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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XXII.—No. 536.

AT THE SOCIETY OF TELEGRAPH ENGINEERS.

THE discussion on the papers of Messrs. Kapp and Mackenzie at the Society of Telegraph Engineers was the most interesting we have heard for some time. It was to be expected that speakers would not confine their remarks strictly to the subjects of the papers, and, of course, it became on the second evening a question of transformers *versus* direct or storage distribution. In our columns will be found a full report of the proceedings, and it will be observed that the difference of opinion expressed by the members is oftimes startling, to say the least of it.

On the first evening the discussion was opened by Prof. Ayrton, who gave the results of some valuable experiments on transformers made by some of his students at the Central Institution. The measurement of the efficiency is of great importance, and from his experiments Prof. Ayrton concludes that for measuring the power given to the apparatus the calorimeter method is the only one which can give correct results. Wattmeters may give errors ranging up to 200 or 300 per cent. Following the last speaker, Captain Cardew referred to the necessity for safety arrangements on the primary and secondary circuits, explaining at length the safety device of his which had been spoken of by Mr. Kapp in his paper. Our own opinion is that too much attention cannot be given to protecting both the supplier and user of the light against risk to life or from fire. The safety device is instituted to cause, when abnormal conditions occur, a local breakdown, which prevents breakdown of the system as a whole. It is therefore most important that it act promptly when required, and that its reliability be unquestionable.

Mr. Alexander Bernstein advocated the series system of connecting transformers. As is well known, the secondary circuit should never be open when working with transformers in series, lamps when turned out being simply short circuited; a short circuit on the secondary therefore is attended with no fire risk, the current remaining of normal strength and the lamps merely going out to give notice of the occurrence. This, we believe, is the only advantage possessed by the series system and there are several disadvantages to balance it, amongst others the expense of carrying a heavy cable wherever lamps are required independently of their number, the less facility with which the branches of fresh consumers can be added, and the difficulty of keeping the current constant in the primary circuit. Under some circumstances these disadvantages might not militate altogether against the system, but it must be remembered that in places where lamps are thickly grouped the mains become just as complex as those of the parallel system without affording corresponding advantages.

The "Connaught" dynamo designed by Mr. Kapp (we think Kapp sounds as well as Connaught for a dynamo) was next described by Mr. Atkinson, who referred to the necessity for keeping down the density of the lines of force in the armatures of alternating current dynamos where the periods of magnetic reversal are short. The Connaught dynamo weighs 2½ tons, runs at 600 revs., and gives 60,000 watts, or about 90 lbs. dead weight to the unit, excluding the weight of the exciter.

Dr. Fleming in his speech referred to magnetic lag, and very properly remarked that we should have to take into account in dealing with transformers magnetic impedance as well as inductive impedance. Several of the speakers questioned the very existence of magnetic lag, but quite illogically to our way of thinking. Whatever magnetism is, whatever molecular motion it necessitates, the movement must take time and the maximum magnetisation must therefore lag behind the maximum magnetising force. That the lag is negligible in continuous current dynamos is no answer to Ayrton, Perry, and Fleming. The lag exists, and though it may be quite negligible in calculations applied to problems in which the periods of reversal are long when these periods are very short, it will doubtless exercise a material influence on the results obtainable. Dr. Fleming also referred to some experiments he had made on Zipernowski transformers in which the power was measured by mammoth wattmeters. Curiously enough Prof. Ayrton now recollected that he had employed a Zipernowski wattmeter which gave results erroneous to the extent of 300 per cent., a recollection which infused some little excitement amongst the audience.

On the second evening the discussion was continued by Mr. Gordon who thinks of giving up alternating currents and going in for storage. On this, perhaps, he is to be congratulated. Mr. Gordon exhibited a diagram showing the way in which the demand for light varies at different hours in the 24, and endeavoured to show that because alternating current dynamos had not been coupled in parallel, and since an engine capable of doing the full load must always run with a big dynamo whether the load is light or heavy, the transformer system must be most uneconomical. As both his assumptions are, we believe, erroneous, the argument falls to the ground. Mr. Crompton followed Mr. Gordon, and contributed largely to the amusement, if not to the edification, of the members. Mr. Crompton was called by Mr. Esson later on the most energetic representative of the anti-transformer party, and his remarks certainly proved his undoubted right to the title. Mr. Crompton was obliged to the Grosvenor Gallery people for showing that there must be storage if public electric lighting is to be a success. He was certain the efficiency was much lower than the efficiency of his own installation in Vienna. He wanted to know *how many tons of coal per lamp* were burnt on the transformer system. He knew the difference in the coal bill of the transformer and direct systems would allow for renewing the batteries over and over again, &c., &c., and &c. A very racy speech with plenty of fun in it but no figures. After all, how much coal does Mr. Crompton burn at Vienna, and what is the efficiency of his accumulators? How does he use them, and what is their depreciation?

Mr. Esson followed Mr. Crompton and referred to the fact that the E.M.F. in alternating current dynamos does not follow the sine curve as assumed by Mr. Kapp. He exhibited a diagram showing the curve he supposed to be actually obtained which certainly departed very considerably from the curve of sines. He condemned the series method of connecting transformers on the score of expense without corresponding advantage. Mr. Esson advised Mr. Kapp to give up alternating currents in view of the contingency of a perfect battery, since it would be a pity though having his leads all right, to find when it arose his transformers and generators of the wrong type. He recommended high potential continuous current generators and continuous current transformers at the sub-stations. As our readers know this method is beginning to create some stir, and where there are sub-stations of 1,000 to 2,000 lights, the objections to the continuous current transformer vanishes, as a man can well be afforded to look after it. With the system storage becomes possible, but Mr. Esson would not advise running into and out of the accumulators, the latter being always kept as a stand-by fully charged, and the leakage only made up now and again by charging from the transformer. In this way a high efficiency is maintained, and an immunity from breaksdown secured.

Mr. Evershed, who followed, said that instead of the transformers filtering an irregular current down into a current following a sine curve, the irregularities would be by the transformers intensified, while Prof. Perry immediately after remarked that the current would, after filtering, follow a perfect sine curve, all the ripples being beautifully smoothed down. This is a point which requires settlement. It is certain that the modifying effect of the transformers is not so great for the parallel as for the series system. We doubt if the modifying effect is great in the former case.

The remarks of the speakers who followed will be reported in another place, and the points to which we desired to call attention have been noticed. Mr. Blakesley, who is a great authority on graphic methods of representing alternating currents, took objection to some of Mr. Kapp's diagrams, and Prof. Thompson, in a speech evidently intended to be at once wise, witty and withering, thought he would in turn have a spar with Mr. Blakesley. Finding nothing to be made of the latter gentleman, he went on to criticise the curves of Mr. Esson and to condemn the shape of his pole pieces, that gentleman audibly remarking that he should like to see the Professor shape them. As a matter of fact, though much can be done by shaping poles, they can never be shaped to make the E.M.F. fulfil the sine law in a machine with an iron core armature, unless the construction is modified in such a way that the leakage of lines becomes enormous. But there is all the difference between dynamos designed on paper and those actually made. Professor Thompson, without adding to the scientific value of the discussion, next attacked Mr. Kapp's classification, and finally abused the paper of Mr. Mackenzie.

With a few remarks from other speakers, there closed a discussion which those who were present will remember with interest for some time to come. The members filed into the tea rooms to form there eager and excited little groups still talking of problems to be solved and methods of solution. At last, at an hour much later than usual, the Institution was deserted. The groups of talkers had melted away, many doubtless to continue the discussion on their way homewards.

WE have received a post-card from the *Railway Supplies Journal* worded as below:—"The editor having been particularly struck with the excellence of your productions, would like to receive particulars thereof, for the purpose of giving an article thereon in this journal." We are quite in the dark as to the meaning of this mysterious application, unless it turns out to be one of a series of cards sent broadcast to traders and manufacturers who are likely to bite at the bait so temptingly offered. A gratuitous advertisement of the REVIEW would, we fear, avail us nothing in the pages of our enterprising contemporary, and, while thanking the editor for his flattering opinion, we beg that he will not uselessly encumber his pages with an article on our productions.

THE position taken up by Mr. J. E. H. Gordon forcibly reminds one of the old adage "Be sure you are off with the old love, before you are on with the new." Who would have dreamt that this very distinguished electrician could have so soon deserted the alternating current system, which but a few short years ago had possession of his every thought? Such, however is the case; but for what reason? Can it be that the experience gained in the Paddington installation has taught him that continuous currents are, like an extensively advertised commodity, the best; or did his American transactions not come up to his expectations? Whatever may be the cause, the unwritten history of Mr. Gordon's electric lighting ventures must be highly entertaining. Never before, we imagine, did the Telegraph Construction and Maintenance Company so fully appreciate the meaning of the word "Maintenance," as during its connection with the subject of our comments, but after all this is only another example of living and learning.

INDIA-RUBBER and gutta-percha are the only two materials which have earned, by lapse of time, a reputation as insulators which can never be gainsaid. It is too often forgotten, however, that each material is at its best under given conditions which, if departed from, may lead to quite unexpected consequences, so that those who are but imperfectly acquainted with the peculiarities of these gums sometimes buy their experience very dearly. We have been allowed to examine some very remarkable specimens of gutta-percha insulated leads which had been used for electric lighting purposes, but in situations so utterly unfitted to the nature of the material as to cause its total decay in a very short period of time. It is only when under water that gutta-percha is practically indestructible.

IN business transactions of many kinds it is not uncommon for purchasers to either require samples of the goods they are about to order, or to submit samples themselves, to which the manufacturers are desired to work. Still more frequently it happens that from various causes which need not be specified, the bulk of the articles or material under contract varies considerably on the wrong side of the specimen products. We have just had submitted to our inspection some half-dozen kinds of conductors cut from the wiring of a London theatre, which has become somewhat notorious through the manner in which the lighting has been carried out. We know not from which portions of the installation the samples come, and we fail to recognise amongst them examples of the conductors which had been previously shown to us, and to which we have already alluded. We could not conscientiously recommend wiring of the nature of these latter samples in any case where great differences of temperature, alternate moisture and dryness, or risk of fire would be incurred, and least of all for use with any high tension transformer system. Nevertheless it is only fair to those who have had this installation in hand, to suppose that when the conductors were laid, the contractors were under the belief that the lighting would be carried out by the theatre proprietors themselves, with continuous currents of low voltage. This, we believe, was originally intended, therefore the conductors, whether good, bad or indifferent, should not be judged from the 2,000 volt alternating current standpoint. Still the matter of insulation for electric light conductors appears to be so little thought of by some electrical engineers, that we shall return to the subject shortly.

THE *Citizen*, one of the representative papers of the City, appears to think that the gas interest is not altogether beyond suspicion of having influenced the Commissioners of Sewers with regard to the lighting of the streets. This may be so, but the "influence" has generally been credited to the Maxim-Weston Company, whose extraordinary action at the last moment has been universally condemned in the electrical press. However, all the talking in the world cannot undo that which has been done, and we can only hope that the opponents of the Brush Corporation's scheme will have had time to come to their senses before the next meeting for considering the subject.

THE United Telephone Company has no easy task before it. It seeks, as our readers know, increased powers for the running of its lines. Telephony in the metropolis will never be satisfactorily carried out until something approaching the compulsory powers possessed by railways and other undertakings are granted to the parties desirous of effecting telephonic communication; whether the United Telephone Company, with all the powers it asks for, would ever succeed in satisfying its subscribers is a matter upon which we do not care to speculate. The justice of its petition, however, is evident to those who are acquainted with the difficulties which crop up when it is desired to connect a new subscriber to an exchange. There are 54 separate petitioners praying to be heard by counsel against the company's proposals, several being railway companies, whilst a large proportion is composed of local authorities. This is not very promising for telephony. In their rage against overhead wires and its imaginary dangers the local authorities quite overlook public convenience and the desirability of facilitating rather than retarding telephonic communication.

MR. W. J. CARRUTHERS WAIN, who is a director of five tramway companies, and may, therefore, be supposed to know the requirements of tramways, spoke at some length upon electric modes of tram traction at the meeting on Monday of the Southwark and Deptford Company. He thinks electrical traction will surpass every other system upon tramways. "This question of electical traction for tramways," he said, "is coming to the front. It is a question that must be dealt with, and dealt with, perhaps, more promptly than any of us imagine." Mr. Wain, in the course of his remarks, made out a strong case for self-contained systems, and condemned as impracticable those which would necessitate the laying down of a third rail, or would involve the danger of a breakdown of the whole line of cars if anything went wrong with the generative system. "You must carry your own power on your own cars, and, still more, it must be of so simple a design that your present cars may be adapted to that system without alteration to your line, or anything of the kind." Mr. Wain's strong advocacy of electricity as the coming power on tramways will probably have a greater effect in bringing about its adoption than anything which has hitherto been said upon the subject. The fact that a man who is above all things practical and who has an intimate acquaintance with tramway work, has expressed his firm conviction in favour of electricity on grounds of economy and practicability will influence other tramway directors who have not yet thought it worth while to heed the laudation of enthusiastic electricians, in whom it is easy to suspect the bias of self-interest. We shall expect Mr. Wain's pronouncement to produce good and early fruit.

A MR. C. H. MURRAY in the columns of the New York *Electrical World* claims to have made some discoveries which, if true, are startling enough. Briefly, he concludes that a current through the body will show no trace of magnetic properties at any part of its circuit, no matter how strong the current. We beg leave to doubt this statement until we hear further particulars. The particulars we should like are (*a*) the magnitude of the current, (*b*) the difference of potentials at the electrodes. We are not aware that when we have been inadvertently introduced into the circuit of a dynamo we exhibited magnetic effects, but we are positive that we exhibited effects infinitely more amusing to beholders.

HERE is an argument against the telegraph and telephone which we venture to say has not been thought of by the strongest opponents of either. It applies, of course, only in suburban and country districts. The advocates of overhead wires must after this, perforce, be dumb. Said Dean Jamieson at Greenock the other day, when objecting to an extension of the telephone lines:—"The poles are unsightly things, and boys are much given to climbing on them!" What more can be said? Overhead wires conducted by poles are doomed.

THE application of the laws of Kirchoff is often a very great stumbling block in the path of students when they first study the subject; but very little has been written on the laws, and this little has to be obtained from sources which are not generally at command. Mr. Rimington's papers on the subject, which we commence in our present issue, will therefore be of particular value.

TELEPHONY AND TELEGRAPHY IN THE TROPICS.

[A COMMUNICATION.]

THE above heading best describes the relative importance of the two systems of communication in the islands of Trinidad and Barbadoes; and it would also fittingly represent the large colony of British Guiana, only there the telephone and telegraph divide the honours between them.

In Trinidad, chiefly represented by the flourishing town known as "the Port of Spain," the telegraphs exist as outside the Post Office, being under the control of the Public Works Department, who built the railway upon which the iron poles of Latimer Clark and Muirhead still stand with their couple of white porcelain insulators, supported by a slight iron arm. Two No. 8 iron wires are run the length of the railway, and single needles are the instruments used. These are worked by two negro lads, and times seemed as easy as in the early days of the late companies in Great Britain. But even the very earliest and most juvenile of inspectors would not tolerate the very slovenly method, or want of method, which allowed the leading in wires to sway about in the wind free of all staples or other holdfasts. Such a thing as casing-in in a heavily-wooded island appears not to have been thought of; whilst the glass cells of the sulphate batteries added a variety to the colour of the dirty corner that did duty for an office. A corner of an old cobbler's stall in Seven Dials is the nearest truthful picture suggested by the Government telegraph office at its headquarters, Trinidad. *Postal* telegraphs there are none, though the genial face of Mr. Berliner (*ex* Cyprus, *ex* Hull) as Postmaster-General for the Island of Trinidad, presides over the Post Office there, winning golden opinions for his courtesy and attention. He is deservedly one of the most popular public men in the West Indies. As for telephones here, they are a splendid success. "380 subscribers and daily expanding" was the statement of the manager who presides over the half-dozen "coloured ladies" operating the exchange. The American Commercial Telephone Company ran up square poles having tiny glass insulators threaded upon a wooden bolt screwed or nailed to an arm on the pole itself, and fixed No. 18 iron wire all over the town, and even a number of miles into the country districts. Their charge is 48 dollars per annum, *but they collect it monthly*. The wires nearly fill some of the streets, and the exchange building is worth looking at outside as well as in. The manager is a gentlemanly young Irishman, formerly with the W. I. and P. T. Co., who left telegraphy for telephonic work. Handsome dividends are paid, and everything works smoothly, and all seems to go "merry as a marriage bell." No earth wires are used and the induction was very slight, whilst speaking was clear and good. Bell telephones and Blake transmitters with magneto ringing was in use with the switchboards supplied by the Western Electric Company.

At Barbadoes a similar success obtains. The tight little island has no telegraphs, but is under the dominion of the telephone company, which holds full sway over an extent of 22 miles by 14, so that long-distance telephony has long since been to them *un fait accompli*.

British Guiana, with Georgetown or Demerara as its headquarters, has both telephones and telegraphs, and both are under the Post Office Department, and the idea is to model both upon home lines, but I fear Mr. Preece would hardly care to be associated with so primitive a system of telegraphs or such defective and badly, nay, recklessly, erected telephone lines or exchange. A glance at the poles and wires in the chief street of the town affords matter for contemplation to the unreflective telegraphist or electrician. The offence against very ordinary, not to say good, taste in placing poles of ugly shape, with arms of all sorts and sizes, from 60 inches to 24 inches, in the most awkward places of the streets, and to note the oddity of display arrived at by fixing the insulators in all sorts of positions on the poles so that no two are exactly alike, is most conspicuous. Never knew those wires the grip of a vice! Hence No. 8 wires dip and curl from pole to pole, cheek-by-jowl with No. 16 iron, and so nicely adjusted are they that the opening of the wooden shutters to give air puts the said wires in contact. Then when a wire is terminated on the insulator it is carried in through the woodwork, which it touches, and is then literally stapled, this bare iron wire, to all the rafters that may intervene between its entrance to the building and its object, the spot where the telephone is. *All joints are dry*. It is troublesome to solder, and many of the so-called joints are a cross between a link-twist and a bell-hanger's one. Such a marvellous combination, that nothing but a photographed group examined by a powerful microscope would reveal. *For the earth an insulated wire must be obtained at all costs!* and in order to have it in accordance with the majority, several sling and dirty joints are necessary before the end is finally dry, wrapped to an old shovel end or bit of iron, and placed in the ground. Such gymnastic work the current from Leclanché cells, of course, laughs at when the bell at the exchange has to be rung up. But the tiny drop has an awkward knack of wanting a certain modicum of current to coax it to fall, and then when it has fallen the whole of the cells used for ringing are deemed necessary to help the Ader microphone to clear its throat and speak correctly. It is well there is no theatre here, as the amusement afforded to the merchants in their offices, and the black boys at the exchange, would prevent their caring to pay for what is now obtained daily for nothing. But seriously, the waste of battery power for the 42 subscribers, which includes some half-dozen Governmental Departments and police, is immense, and failures of the indicator drops frequent. Magneto bells would reduce the batteries to their legitimate work, viz., speech by telephone,

The late Telegraph Superintendent retired in May, and the maintenance of matters have been kept "*going*" till the newly-titled "electrician" arrived. Happy man! We believe he has "arroven," and taken a few bearings and sketches, convinced that such unique specimens of electrical engineering could not be found in any other part of the globe. Under such circumstances, it cannot be wondered at that Mr. Melton Prior, the celebrated war artist of the *Illustrated London News*, deemed the three-legged terminal pole in front of the telegraph shanty—we beg pardon, we mean the telegraph *office* (so like a shanty), in its isolation from the post office proper 150 yards away—a fitting study for his recent sketches of Georgetown.

The telegraphs of the colony comprise some 36 offices, open from 6.30 a.m. to 5.30 p.m., and the five circuits are all worked on the closed-current principle, notwithstanding that there are some seven cables ranging from 100 yards to 5 miles. These all have a current kept on them night and day, and the tiny American Bell sounders are worked by black boys, who are quite smart as operators. The rates are cheap, being sixpence for ten words, and addresses free, which is cheaper than home rates.

ON THE DIFFERENCE OF PHASES OF CURRENTS, ON THE RETARDATION OF INDUCTION, AND ON THE DISSIPATION OF ENERGY IN TRANSFORMERS. EXPERIMENTAL AND THEORETICAL RESEARCHES.

By PROF. GALILEO FERRARIS.

(*Continued from page* 192.)

THE relations (24), (25), (25′), (25″), in demonstrating which we have not had need to form any hypotheses as to the cause of the retardation, θ, are absolutely general and exist whatever may be the cause. The same relations may be arrived at by means of a consideration of the Foucault currents. We find that for a given transformer and for a given resistance of the secondary circuit, the loss of energy due to the Foucault currents represents a fraction of the energy expended, so much the smaller the greater the number of inversions which take place in each unit of time. There are certainly limits at which our equations cease to be even approximately applicable. But in any case we can deduce from the considerations given that from the determinations of the coefficient of yield obtained experimentally with currents of a given period it is not possible without other data or other measurements to infer the value of the corresponding yield for another value of the period, T, and for another number of inversions.

Coefficients of Yield.

If we admit that the dissipation of energy spoken of, including both that due to the Foucault currents and that due to the periodical magnetisation and demagnetisation of the iron represents the most important part of the loss of useful effect determined in the transformer, we shall then be able to admit that at least for a transformer well constructed and well insulated, we may make use of the foregoing results for deducing an expression of the coefficient of yield of the apparatus, also an expression of the relation between the energy produced in the secondary circuit, or that which is available in its external portion and the energy expended within the transformer to make it work.

Calling w the resistance in the secondary coil, W that in the primary, ε_1 the ratio of the energy produced in the secondary inner circuit and the total energy expended, and ε_2 the ratio of the utilisable energy in the outer part of the secondary circuit, and the total energy expended we have

$$\varepsilon_1 = \frac{r}{r + \mathrm{W}\left(\frac{\mathrm{A}}{\mathrm{B}}\right)^2 + r\frac{\mathrm{P}}{\mathrm{Q}}} \qquad (28)$$

$$\varepsilon_2 = \frac{r - w}{r + \mathrm{W}\left(\frac{\mathrm{A}}{\mathrm{B}}\right)^2 + r\frac{\mathrm{P}}{\mathrm{Q}}}. \qquad (29)$$

We can call these two relations, the coefficient of total yield or the coefficient of external or useful yield.

If we have a transformer with a closed magnetic circuit like those of Zipernowski, Déri, and Bláthy, it follows that if n and n' are the numbers of turns in the primary and secondary coils

$$\frac{\mu}{\lambda} = \frac{n}{n'}.$$

But in a secondary generator with an open magnetic circuit like the original instruments of Gaulard and Gibbs with which have been performed the experiments described in this memoir, the above relation is merely approximate, but if, as in the case of the apparatus indicated, the turns of the two spirals are all equal, and those of the primary alternate regularly with those of the secondary the approximation is always great, greater, indeed, than that which is required in measurements for technical purposes. In each case $\frac{\mu}{\lambda}$ may be determined experimentally. A method of doing this consists in determining for any very small values of r the corresponding ones of $\frac{c}{b}$ plotting out with them a short space of the line A, B (fig. 2) which in the neighbourhood of the axis of the ordinates may coincide with a right line, and finding the ordinate O, A, of the point, A, where this, if produced, cuts the axis of the ordinates. This ordinate, O, A, represents $\frac{\lambda}{\mu}$.

Results of the Experiments.

With the instruments above described, five series of experiments were made, all with the same secondary generator with the coils always connected in the same manner, but using for each series a different iron core. No. 1 core was of the kind commonly used in practice. It consisted of a cylinder of wood covered with oxidised* iron wire of the diameter of 0·65 millimetres. The inclusive diameter was 46 mm. and the total weight 2·92 kilos.

No. 2 was also formed of a cylinder of wood covered with wires of insulated iron 3·3 mm. in diameter. The diameter of the wood was 20 mm., the inclusive diameter 43 and the weight of the whole 3·55 kilos.

No. 3 was formed of 16 prismatic bars of soft iron having a trapeziform section of about 60 square millimetres, insulated and all supported around a central cylinder of wood. The mean entire diameter was 43 mm., that of the wood 20, and the weight 3·44 kilos.

No. 4 consisted of a drawn tube of iron, 3 mm. in diameter, with an outer diameter of 44 mm. and a weight of 2·16 kilos.

Lastly, No. 5 was a solid iron bar, 42 mm. in diameter, and of the weight of 6·59 kilos.

This series of cores was selected with a view to render more and more sensible the effects of the Foucault currents and to be able to determine if, with the increase of these effects, the retardation, θ, and the values of μ and λ would actually vary in the manner predicted in our theoretical considerations.

We have demonstrated the fundamental fact that the relation $\frac{c}{b}$ in place of being independent of r, as the theoretical equations would indicate, increase with the increase of this variable.

The results of the experiments are briefly given in the following tables :—

Core No. 1.

No.	r	$\frac{a}{b}$	$\frac{c}{b}$	$\frac{c}{b}$ calculated.
1	0,409	1,026	1,010	1,017
2	1,953	1,117	1,039	1,035
3	3,224	1,215	1,054	1,051
4	4,462	1,363	1,074	1,066
5	5,713	1,561	1,082	1,082
6	6,958	1,784	1,097	1,097
7	8,542	2,152	1,109	1,116
8	9,760	2,569	1,134	1,131
9	11,000	2,923	1,142	1,146
10	12,240	3,476	1,162	1,162
11	13,470	4,249	1,167	1,177
12	14,790	4,969	1,203	1,193

Core No. 2.

No.	n	r	$\frac{a}{b}$	$\frac{c}{b}$	$\frac{c}{b}$ calculated.
1	600	0,409	1,030	1,011	1,016
2	602	1,953	1,119	1,050	1,043
3	602	3,224	1,232	1,073	1,065
4	603	4,462	1,364	1,078	1,086
5	602	5,713	1,540	1,109	1,108
6	601	6,958	1,746	1,131	1,130
7	603	8,542	2,055	1,159	1,157
8	604	9,760	2,319	1,174	1,179
9	602	11,000	2,768	1,195	1,200
10	601	12,240	3,118	1,224	1,222
11	603	13,470	2,355	1,228	1,243
12	603	14,790	3,837	1,284	1,266

---

* *Sic.* ? insulated.

Core No. 3.

No.	n	r	$\frac{a}{b}$	$\frac{c}{b}$
1	599	0,409	1,050	1,039
2	602	1,953	1,217	1,087
3	604	3,224	1,438	1,154
4	602	4,462	1,719	1,202
5	603	5,713	2,146	1,286
6	602	6,958	2,611	1,392
7	601	8,542	3,315	1,464
8	601	9,760	4,110	1,615
9	601	11,000	4,630	1,645
10	601	12,240	5,280	1,739

Core No. 4.

No.	n	r	$\frac{a}{b}$	$\frac{c}{b}$
1	603	0,409	1,083	1,045
2	602	1,953	1,503	1,197
3	605	3,224	2,086	1,367
4	600	4,462	2,793	1,514
5	601	5,713	3,773	1,700
6	603	6,958	4,686	1,832
7	600	8,542	6,106	2,083
8	603	9,760	7,294	2,213

Core No. 5.

No.	n	r	$\frac{a}{b}$	$\frac{c}{b}$
1	602	0,409	1,140	1,073
2	602	1,953	1,636	1,261
3	603	3,224	2,352	1,457
4	603	4,462	3,255	1,666
5	603	5,713	4,335	1,869
6	604	6,958	5,564	2,080
7	601	8,542	7,173	2,263

(*To be concluded.*)

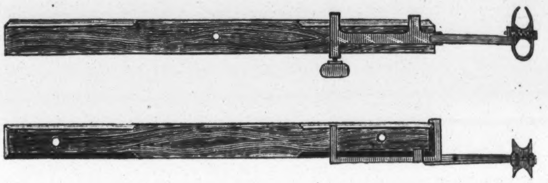
RENEWING TELEGRAPH AND TELEPHONE WIRES.

THE frequent interruptions caused by earths and contacts during renewal operations have at all times been a source of much annoyance to telegraph engineers. Considerable attention seems, however, to have been given to the matter lately, and various appliances, two of which were fully described in our issue of last week, have been designed to avoid stoppages from this cause, and to maintain uninterrupted communication while new wires are being run.

Particulars have been furnished of another appliance designed and patented some time ago by the Caledonian Railway Company's engineer, Mr. Dunn. Practically perfect results are said to have been obtained by means of this tool, while the use of it, instead of retarding work, as might seem at first sight to be the case, facilitates it to such an extent that at least 20 per cent. more can be done.

The runner as shown in the sketch is attached to the arm by transverse jaws and an under pinching screw, and the outer end carries a free pulley over which the new wire is run. The pulley is a special feature of the tool, as it offers little or no resistance to the wire, and in drawing out enables one man to do the work hitherto done by two. The "scouring" and "skinning" which takes place when wire is drawn over rough ground, or over arms, against insulator bolts or other rigid surfaces, is also completely obviated, and the wire is got into position without the zinc coating being broken or in any way impaired.

The method of using is as follows :—One runner is attached to a long arm on each pole along the section over which a coil of new wire will run. The wire is then drawn out over the runners, and as these project, keeps quite clear of the standing wires on the poles. When drawn out the wire is viced up on the runners and exchanged with the old wire, after which the latter is cut down. The whole process is gone through without the new or old wire getting foul of any other wire on the poles, and as this result is obtained not only without prejudice to the speed of work but with very considerable acceleration to it, it is expected that the tool will be generally introduced.



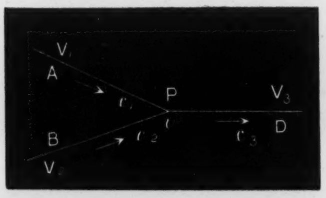
It will be apparent that it is much easier to lift the bight of the wire on to the runners as it is being drawn out than to thread the wire over the arm between the insulator and the pole, as is done under the old system.

A number of appliances had been designed and tested by Mr. Dunn, but it was found after considerable experience that the one now described is most suitable for the work. Its advantages are that it is light and portable and can be quickly and securely attached without boring or cutting the arm. It provides complete immunity from interruptions and facilitates the work. It prevents injury to the anti-corrosive coating of the wire, and adapts itself to the system of drawing wires out.

KIRCHOFF'S LAWS AND THEIR APPLICATION.

By E. C. RIMINGTON.

IN most text books on electricity the two laws of Kirchoff are given in a brief form, and little, if anything, is said about their application to the finding of currents in a network of conductors. In these articles the writer hopes to give a clear description of the latter part of the subject principally. The first law or "condition of continuity," as it is often called, may be thus enunciated. "In any network of conductors containing currents, the algebraical sum of the currents meeting at any one point is zero; the currents being reckoned positive or negative accordingly as they flow towards or away from that point or *vice versâ.*"



Suppose the currents, c_1 and c_2, to flow towards the point, P and c_3 away from it. Let the potential of P be v, and those of the points, A, B, and D, taken anywhere in the three conductors, be V_1 V_2 and V_3 respectively. By the first law $c_1 + c_2 - c_3 = 0$. If $c_1 + c_2 - c_3$ does not equal zero, let it be greater than zero, *i.e.*, let $c_1 + c_2$ be greater than c_3. Let r_1 r_2 and r_3 be the resistances of the conductors between A and P, B and P, and D and P : then

$$c_1 = \frac{V_1 - v}{r_1},\ c_2 = \frac{V_2 - v}{r_2} \text{ and } c_3 = \frac{v - V_3}{r_3}.$$

$c_1 + c_2$ is the quantity of electricity flowing to the point, P, per second, and c_3 the quantity leaving P per second, hence $c_1 + c_2 - c_3$ represents the quantity, which accumulates at P per second. Now, as the quantity of electricity at P increases, the potential of P or v must also increase, and in consequence $c_1 + c_2$ will diminish and c_3 increase, and it is obvious that v will go on increasing until $c_1 + c_2 = c_3$, in which case the quantity flowing per second to P will equal the quantity which leaves it per second, and therefore its potential will remain constant.

Kirchoff's first law may be symbolically written

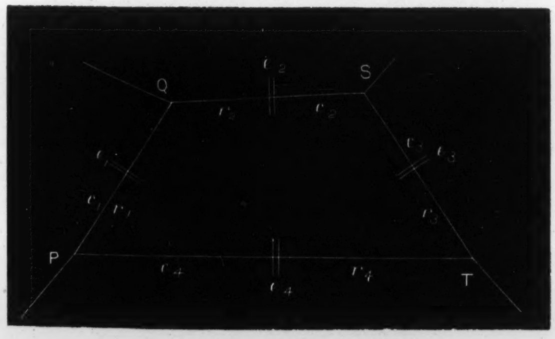
$$\Sigma\, c = 0.$$

The second law is an extension of Ohm's law to a circuit, in which the current is not of the same value in every part. The enunciation is as follows:—"In a network of conductors containing currents and E.M.Fs. if any closed circuit be taken, the algebraical sum of the products of the current in each conductor into the resistance of that conductor taken round that circuit is equal to the algebraical sum of the E.M.Fs. acting round that circuit. Currents flowing, or E.M.Fs. acting round the circuit in one direction being taken as positive, those in the reverse direction as negative."

To prove this second law of Kirchoff we require Ohm's law put in its most general form, which is

$$c = \frac{\mathrm{V} - \mathrm{V}_1 + \Sigma\,\mathrm{E}}{\Sigma\,\mathrm{R}}:$$

where c is the current flowing in any conductor from V to V_1; V is the potential of one end of the conductor and V_1 that of the other end; $\Sigma\,\mathrm{E}$ is the algebraical sum of the E.M.Fs. acting in the conductor, those acting from V to V_1 being taken as positive, and those from V_1 to V as negative; $\Sigma\,\mathrm{R}$ is the resistance of the conductor between V and V_1. If c works out negative it of course means that the current is from V_1 to V. If the conductor is a complete circuit V and V_1 are the same point; hence $\mathrm{V} = \mathrm{V}_1$; and $c = \frac{\Sigma\,\mathrm{E}}{\Sigma\,\mathrm{R}}$, the form in which Ohm's law is generally expressed.



Let the circuit P Q S T be some complete circuit in a network of conductors. Let r_1 r_2 r_3 and r_4 be the resistances of the conductors; c_1 c_2 c_3 and c_4 the currents flowing in them respectively, the symbols denoting the currents being positive or negative quantities accordingly as the currents act round the circuit clockwise or counter-clockwise; e_1 e_2 e_3 and e_4 the E.M.Fs. acting in the four conductors respectively, also including their signs with with reference to the direction, in which they act round the circuit, in the same manner as the currents. Let P, Q, S and T be the potentials of those points.

Applying the general form of Ohm's law given above to r_1 we have:

$$c_1 = \frac{\mathrm{P} - \mathrm{Q} + e_1}{r_1},$$

or

$$c_1\, r_1 = \mathrm{P} - \mathrm{Q} + e_1\,;$$

similarly

$$c_2\, r_2 = \mathrm{Q} - \mathrm{S} + e_2$$

$$c_3\, r_3 = \mathrm{S} - \mathrm{T} + e_3$$

$$c_4\, r_4 = \mathrm{T} - \mathrm{P} + e_4.$$

Adding, we obtain $c_1\, r_1 + c_2\, r_2 + c_3\, r_3 + c_4\, r_4 = e_1 + e_2 + e_3 + e_4$, or the algebraical sum of the products of the currents and the resistances equals the algebraical sum of the E.M.Fs. Note that when we write $c_1 = \frac{\mathrm{P} - \mathrm{Q} + e_1}{r_1}$ c_1 is the current from P to Q, that is, the current flowing round the circuit clockwise, if c_1 worked out negative it flows from Q to P or counter clockwise round the circuit; the same applies to the other currents.

Kirchoff's second law may be symbolically written

$$\Sigma\, c\,\mathrm{R} = \Sigma\,\mathrm{E}.$$

If the current is the same throughout the circuit $\Sigma\, c\,\mathrm{R} = c\,\Sigma\,\mathrm{R}$, so that $c\,\Sigma\,\mathrm{R} = \Sigma\,\mathrm{E}$; which is Ohm's law, as the circuit is then a simple one.

The principle use of Kirchoff's two laws, as was mentioned before, is to obtain the value of the current in any branch of a network of conductors in terms of the resistances of the branches of the network and the E.M.Fs. acting therein. It is necessary now to consider how to obtain the equations requisite to give the value of any one of the currents. In the first place nothing will in general be known as to the actual directions of the currents in the various conductors, and, as for the application of the two laws, the relations between the directions of the currents requires to be given, it will be necessary to assume arbitrary directions for the latter. This is best done by drawing an arrow head to every conductor and supposing that the current in it flows in the direction of this arrow head. How these latter is drawn is totally immaterial, provided that all the equations are obtained on the supposition that the currents flow as represented. If, when the value of any current is obtained by the solution of the equations, it is found to be positive, the real direction of the current is the same as the assumed one, if negative the reverse direction.

Next it is necessary to assume a different current to flow in each conductor (though we may afterwards find that some of the currents are identical in value), and as the value of each of the currents is unknown as many *independent* equations will be required as there are conductors; some of these equations must be deduced from the first law and the rest from the second.

If n points are joined by p lines, none of the latter intersecting, it will be found that $p - n + 1$ meshes are formed; if these lines represent conductors there will be p unknown currents, and hence p independent equations must be obtained. Of these $p - n + 1$ can be obtained by applying the second law round each mesh, and the remaining $n - 1$ by applying the first law to any $n - 1$ out of the n points where the conductors meet. It is obvious that if only two conductors meet at a point the current in each of them is the same and we may regard them as one conductor.

The equations obtained by applying the second law to each mesh and obtaining the remainder from the first law will all be found to be independent. Of course n equations could be obtained from the first law since there are n points, but one of these equations can always be derived from the other $n - 1$.

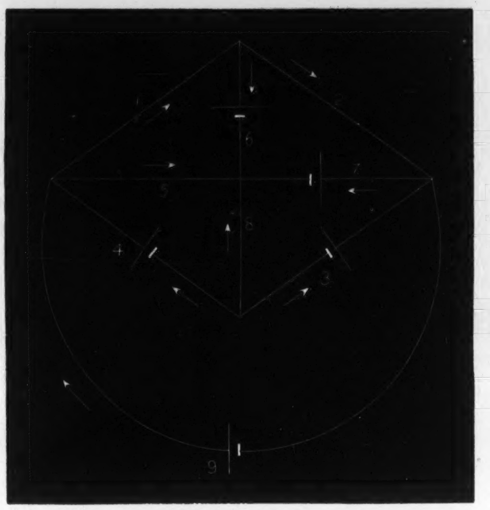
As an example of the foregoing explanations take the following network system.

Let the resistances of the branches be r_1 r_2 r_3 &c.; the currents c_1 c_2 c_3 &c.; and the E.M.Fs. e_3 e_4 e_6 e_7 and e_9. Arrows are drawn in any direction, and the currents are assumed to flow in the directions thus indicated.

The number of points is 5, and the number of conductors 9; hence 9 independent equations are required, of which $9 - 5 + 1$ or 5 must be obtained from the application of the second law round each of the 5 meshes, and the remaining 4 from the application of the first law to any four of the 5 points.

Commencing with the left hand top mesh we obtain

$$c_1 r_1 + c_6 r_6 - c_5 r_5 = - e_6 \qquad (1)$$



From the top right hand mesh

$$c_2 r_2 + c_7 r_7 - c_6 r_6 = e_6 - e_7 \qquad (2)$$

Similarly

$$c_8 r_8 - c_7 r_7 - c_3 r_3 = e_7 - e_3 \qquad (3)$$

$$c_5 r_5 - c_8 r_8 + c_4 r_4 = e_4 \qquad (4)$$

$$c_9 r_9 - c_4 r_4 + c_3 r_3 = e_9 - e_4 + e_3 \qquad (5)$$

The remaining four equations from the first law will be

$$c_9 + c_4 - c_1 - c_5 = 0 \qquad (6)$$

$$c_1 - c_2 - c_6 = 0 \qquad (7)$$

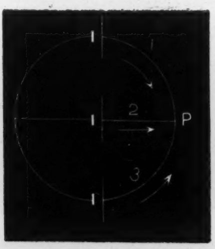
$$c_2 + c_3 - c_7 - c_9 = 0 \qquad (8)$$

$$c_5 + c_6 + c_7 + c_8 = 0 \qquad (9)$$

The remaining equation, viz.: $- c_4 - c_3 - c_8 = 0$ or $c_4 + c_3 + c_8 = 0$ can be obtained by adding the above four.

From these nine equations by simple algebra any eight of the quantities $c_1\ c_2\ c_3$ &c. can be eliminated and the remaining one found in terms of the resistances and E.M.Fs.

Let us now consider the case of a network where the number of points is two. When the number of conductors is also two, the current in each of them is obviously the same, and we have a simple circuit.



Let the number of conductors be three, we have then a two mesh circuit. Let, as before, the resistances of the branches be $r_1\ r_2\ r_3$, the currents $c_1\ c_2$ and c_3, and the E.M.Fs. $e_1\ e_2$ and e_3. Suppose the E.M.Fs. to be all acting towards P, one of the two points, and draw the arrows so as to represent the currents as all flowing towards P.

We obtain the following three equations :—

$$c_1 r_1 - c_2 r_2 = e_1 - e_2 \qquad (1)$$

$$c_2 r_2 - c_3 r_3 = e_2 - e_3 \qquad (2)$$

$$c_1 + c_2 + c_3 = 0 \qquad (3)$$

Multiplying (3) by r_3 and add (2) to it and we obtain:

$$c_1 r_3 + c_2 (r_2 + r_3) = e_2 - e_3 \qquad (4)$$

Multiply (4) by r_2

$$c_1 r_2 r_3 + c_2 r_2 (r_2 + r_3) = e_2 r_2 - e_3 r_2$$

multiply (1) by $(r_2 + r_3)$

$$c_1 (r_1 r_2 + r_1 r_3) - c_2 r_2 (r_2 + r_3) = e_1 (r_2 + r_3) - e_2 r_2 - e_2 r_3.$$

Add

$$c_1 (r_1 r_2 + r_1 r_3 + r_2 r_3) = e_1 (r_2 + r_3) - e_2 r_3 - e_3 r_2$$

or

$$c_1 = \frac{e_1 (r_2 + r_3) - e_2 r_3 - e_3 r_2}{r_1 r_2 + r_1 r_3 + r_2 r_3}$$

Similarly

$$c_2 = \frac{e_2 (r_1 + r_3) - e_1 r_3 - e_3 r_1}{r_1 r_2 + r_1 r_3 + r_2 r_3}$$

and

$$c_3 = \frac{e_3 (r_1 + r_2) - e_1 r_2 - e_2 r_1}{r_1 r_2 + r_1 r_3 + r_2 r_3}$$

If any of the E.M.Fs. act in the opposite way to that drawn in the diagram the sign of the terms containing that E.M.F. must be changed: thus, if e_2 be reversed c_1 becomes

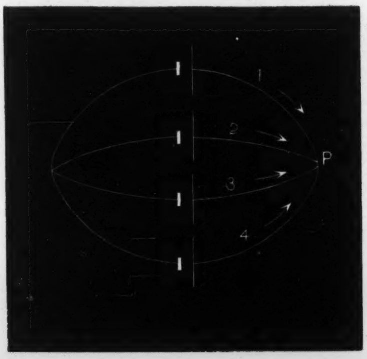
$$\frac{e_1 (r_2 + r_3) + e_2 r_3 - e_3 r_2}{r_1 r_2 + r_1 r_3 + r_2 r_3}.$$

It is obvious that at least one of the currents must be negative, as they cannot all really flow towards P.

If $e_2 = 0$

$$C_2 = \frac{- e_1 r_3 - e_3 r_1}{r_1 r_2 + r_1 r_3 + r_2 r_3}.$$

In order that c_2 shall equal zero, $e_1\ r_3$ must equal $- e_3 r_1$, or $\frac{e_1}{e_3} = - \frac{r_1}{r_3}$. That is to say, the E.M.Fs. must act in contrary directions as regards P, or round the circuit in the same direction, and bear to one another the ratio of the resistances of the branches in which they act. If branch 2 contain a galvanometer, and branches 1 and 3 adjustible resistances, which can be altered until the galvanometer indicates no current, we obtain the method for comparing two E.M.Fs. generally known as Lumsden's.



If the number of conductors be four, the equations are :—

$$c_1 r_1 - c_2 r_2 = e_1 - e_2 \qquad (1)$$

$$c_2 r_2 - c_3 r_3 = e_2 - e_3 \qquad (2)$$

$$c_3 r_3 - c_4 r_4 = e_3 - e_4 \qquad (3)$$

$$c_1 + c_2 + c_3 + c_4 = 0 \qquad (4)$$

Solving these four equations for c_1 we obtain :—

$$c_1 = \frac{e_1 (r_2 r_3 + r_2 r_4 + r_3 r_4) - e_2 r_3 r_4 - e_3 r_2 r_4 - e_4 r_2 r_3}{r_1 r_2 r_3 + r_1 r_2 r_4 + r_1 r_3 r_4 + r_2 r_3 r_4}.$$

The values of $c_2\ c_3$ and c_4 can be obtained from c_1 by interchanging the suffixes, since the circuit is symmetrical as regards P. Note that the denominator is the same in each case.

For five conductors :—

$$c_1 = \frac{e_1 (r_2 r_3 r_4 + r_2 r_3 r_5 + r_2 r_4 r_5 + r_3 r_4 r_5) -}{r_1 r_2 r_3 r_4 + r_1 r_2 r_3 r_5 + r_1 r_2 r_4 r_5 +}$$
$$\frac{e_2 r_3 r_4 r_5 - e_3 r_2 r_4 r_5 - e_4 r_2 r_3 r_5 - e_5 r_2 r_3 r_4}{r_1 r_3 r_4 r_5 + r_2 r_3 r_4 r_5}$$

In a similar manner the current in any conductor out of 6, 7, or more, can be obtained.

By inspecting the method of formation of the value of the currents in the above the following general rule can be deduced.

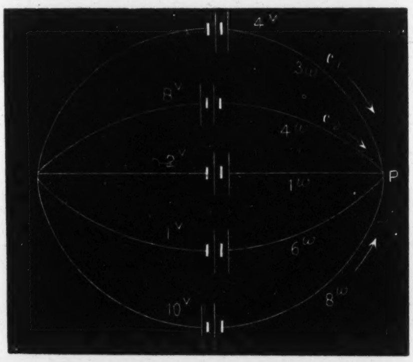
"If 'n' conductors of resistances, $r_1\ r_2\ r_3 \ldots r_n$, join two points and contain E.M.Fs. $e_1\ e_2\ e_3 \ldots e_n$ respectively, these E.M.Fs. all acting towards one of the two points, the current flowing towards that point in any one of the conductors equals the E.M.F. acting in that conductor multiplied by the sum of the combinations of the resistances of the other '$n - 1$' conductors taken '$n - 2$' at a time, minus the sum of the products of the E.M.F. acting in each of the other conductors into the product of the resistances of all the conductors except the one, in which this E.M.F. acts, and the one, in which the required current flows: the whole divided by the sum of the combinations of all the 'n' resistances taken '$n - 1$' at a time."

Or,

$$c_1 = \frac{e_1 (r_3 r_4 r_5 \ldots r_n + r_2 r_4 r_5 \ldots r_n + r_2 r_3 r_5 \ldots r_n + \&c.) -}{r_2 r_3 r_4 r_5 \ldots r_n + r_1 r_3 r_4 r_5 \ldots r_n +}$$
$$\frac{\{e_2(r_3 r_4 r_5 \ldots r_n) + e_3(r_2 r_4 r_5 \ldots r_n) + e_4(r_2 r_3 r_5 \ldots r_n) + \&c.\}}{r_1 r_2 r_4 r_5 \ldots r_n + r_1 r_2 r_3 r_5 \ldots r_n + \&c.}$$

The following is a numerical example of the application of the foregoing results to a five-branch circuit.

If P be the point chosen; $e_1 = 4$; $e_2 = -8$; $e_3 = 2$; $e_4 = 1$; $e_5 = -10$.



Hence

$$c_1 = \frac{4(1.6.8 + 4.6.8 + 4.1.8 + 4.1.6) - \{(-8).1.6.8 +}{4.1.6.8 + 3.1.6.8 + 3.4.6.8 +}$$
$$\frac{(2).4.6.8 + 1.4.1.8 + (-10)\,4.1.6\}}{3.4.1.8 + 3.4.1.6}$$

$$= \frac{4 \times 296 + 384 - 384 - 32 + 240}{192 + 144 + 576 + 96 + 72} = \frac{1392}{1080} = 1{\cdot}2\dot{8}$$

$$c_2 = \frac{-8(1.6.8 + 3.6.8 + 3.1.8 + 3.1.6) -}{1080}$$
$$\frac{\{4.1.6.8 + 2.3.6.8 + 1.3.1.8 + (-10)\,3.1.6\}}{}$$

$$= \frac{-2196}{1080} = -2{\cdot}0\dot{3}$$

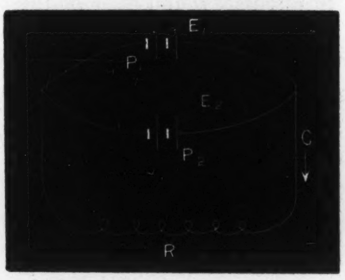
c_2 being negative flows in the opposite direction to the arrow representing it or away from P. In the same manner $c_3\ c_4$ and c_5 can be determined.

A theorem specially convenient for the calculation of the current in any branch of circuits similar to the foregoing was described by the writer in this Journal, Vol. XVIII., p. 371. The theorem is as follows:—"If there are two batteries in parallel they are equivalent as regards the external circuit to a new battery, whose E.M.F. equals the E.M.F. of one of them multiplied by the resistance of the other plus, the E.M.F. of the latter multiplied by the resistance of the former, the sum being divided by the sum of their internal resistances; and whose internal resistance is the joint resistance of the two batteries."

To prove this theorem we must first show that if $\frac{a}{b + x} = \frac{a_1}{b_1 + x}$ (where $a\ a_1$, b and b_1 are constants, and x a variable) for every value of x, then $a = a_1$ and $b = b_1$.

Since $\frac{a}{b + x} = \frac{a_1}{b_1 + x}$ for every value of x, let $x = -b$, then the left hand side of the equation becomes $\frac{a}{0}$ or infinite and the right hand side $\frac{a_1}{b_1 - b}$, but in order that the equation shall hold, this latter quantity must be infinite, and as a_1 is finite $b_1 - b$ must equal zero or $b = b_1$; hence $\frac{a}{b + x} = \frac{a_1}{b + x}$ and therefore $a = a_1$.

Let two E.M.Fs., E_1 and E_2 having resistances ρ_1 and ρ_2 respectively be joined in parallel and circuited through an external circuit of resistance, R, in which the current is c.



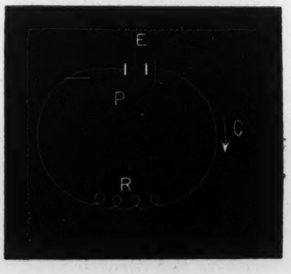
By Kirchoff's laws

$$c = \frac{E_1 \rho_2 + E_2 \rho_1}{\rho_1 \rho_2 + \rho_1 R + \rho_2 R}$$

This may be written

$$c = \frac{\dfrac{E_1 \rho_2 + E_2 \rho_1}{\rho_1 + \rho_2}}{\dfrac{\rho_1 \rho_2}{\rho_1 + \rho_2} + R}$$

Let E be the E.M.F. and ρ the resistance of a battery that will send the same current, c, through R as that given by the two E.M.Fs. in parallel.



Then $$c = \frac{E}{\rho + R}$$

Hence $$\frac{E}{\rho + R} = \frac{\dfrac{E_1 \rho_2 + E_2 \rho_1}{\rho_1 + \rho_2}}{\dfrac{\rho_1 \rho_2}{\rho_1 + \rho_2} + R}$$

Now this latter equation must hold for every value of R, and since $E\ \rho\ E_1\ E_2\ \rho_1$ and ρ_2 are constants

$$E = \frac{E_1 \rho_2 + E_2 \rho_1}{\rho_1 + \rho_2} \quad \text{and} \quad \rho = \frac{\rho_1 \rho_2}{\rho_1 + \rho_2}$$

which proves the theorem.

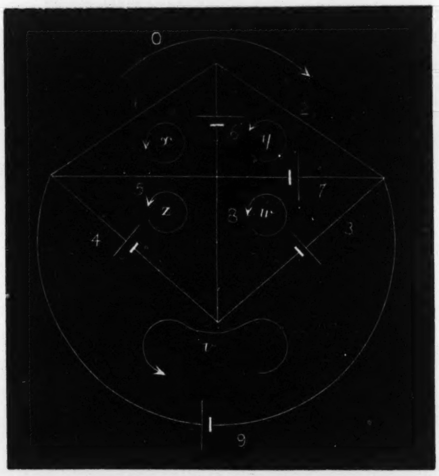
If either of the E.M.Fs. are reversed the sign of that E.M.F. becomes negative and it will tend to send a current through R in the reverse direction, so that the E.M.Fs. must be taken as positive or negative according to the direction of the current they tend to send through the external circuit.

If $E_2 = 0$ and $\rho_2 = S$ $E = \frac{E_1 S}{\rho_1 + S}$ and $\rho = \frac{\rho_1 S}{\rho_1 + S}$ a result generally known as Pollard's theorem of a shunted battery.

It will be seen that if $\rho_1 = \rho_2$, $E = \frac{E_1 + E_2}{2}$, the arithmetical mean of E_1 and E_2 and if $E_1 = E_2$. $E = E_1 = E_2$. For further particulars about this method the reader is referred to the article above mentioned.

A method of calculating the current in any conductor out of a network much used at the present time is the one due to Clerk-Maxwell (Maxwell's Electricity and Magnetism, 2nd edition, Vol. I., paragraph 282*b*, page 374), and of which a detailed description was given in a paper read by Dr. Fleming before the Physical Society of London, June 27th, 1885.

In the same network circuit, as was first considered in showing the application of Kirchoff's two laws, imagine a current to circulate round each of the five meshes. Let these imaginary currents be x y z w and v as shown in the diagram, and suppose them to be all circulating in the same direction, viz., counter clockwise, which is generally taken as the positive direction.



Let the resistances of the conductors be as before r_1 r_2 r_3 &c., the real currents in them c_1 c_2 c_3 &c., and the E.M.Fs. e_3 e_4 e_6 and e_9.

Consider conductor 5, we have the current x flowing through it from left to right and the current z from right to left; this is the same thing as a current $x - z$ from left to right, which is the numerical value of the real current in it or c_5.

Similarly $c_1 = x$, $c_2 = y$, $c_3 = w - v$, $c_4 = z - v$, $c_6 = x - y$, $c_7 = y - w$, $c_8 = w - z$, $c_9 = v$.

Now if we suppose the directions of the real currents to be as represented by the arrows in the former diagram

$$c_1 = -x,\ c_2 = -y,\ c_3 = w - v,\ c_4 = v - z,\ c_5 = x - z,$$
$$c_6 = y - x,\ c_7 = w - y,\ c_8 = z - w,\ c_9 = -v.$$

Substituting these values in the first five equations which were obtained from Kirchoff's second law we have:

$$-x r_1 + (y - x) r_6 - (x - z) r_5 = -e_6$$
$$-y r_2 + (w - y) r_7 - (y - x) r_6 = e_6 - e_7$$
$$(z - w) r_8 - (w - y) r_7 - (w - v) r_3 = e_7 - e_3$$
$$(x - z) r_5 - (z - w) r_8 + (v - z) r_4 = e_4$$
$$-v r_9 - (v - z) r_4 + (w - v) r_3 = e_9 - e_4 + e_3$$

Rearranging

$$-x (r_1 + r_5 + r_6) + y r_6 + z r_5 = -e_6$$

or

$$(r_1 + r_5 + r_6) x - r_6 y - r_5 z = e_6$$

Similarly

$$(r_2 + r_6 + r_7) y - r_6 x - r_7 w = e_7 - e_6$$
$$(r_3 + r_7 + r_8) w - r_7 y - r_8 z - r_3 v = e_3 - e_7$$
$$(r_4 + r_5 + r_8) z - r_5 x - r_8 w - r_4 v = -e_4$$
$$(r_3 + r_4 + r_9) v - r_4 z - r_3 w = e_4 - e_3 - e_9.$$

The four equations derived from the first law all become $0 = 0$, which is what would be expected, as the nine unknowns are now reduced to five, viz.: x y z w and v.

These latter go by the name of cyclic symbols; x being the cyclic symbol of the mesh, or cycle, formed by the conductors 1, 6, and 5, which may be briefly denominated as "the x cycle;" y is that of the mesh formed by the conductors 2, 6, and 7, and so on. It is thus seen that the real current in any conductor is the difference between the values of the cyclic symbols of the two meshes, which it separates. In order to make this form of notation quite symmetrical we must consider the outside space as being a mesh, whose cyclic symbol is zero;* hence

$$c_1 = o - x, \qquad c_2 = o - y, \qquad c_9 = o - v.$$

We now only require as many equations as there are meshes instead of, as before, as many as there are conductors, which results in a considerable saving of labour in the solution of the equations. By inspection of the equations that have been obtained it will be seen that the equation to each mesh can be obtained by means of the following rule.

"Multiply the cyclic symbol of the mesh by the sum of the resistances bounding it, and subtract the cyclic symbol of each neighbouring mesh multiplied respectively by the common bounding resistance, and equate this result to the algebraical sum of the E.M.Fs. acting round the mesh; those acting in the direction of the cyclic symbol being taken as positive, and those in the reverse direction as negative."

The above five equations may be written thus:—

$$(r_1 + r_5 + r_6) x - r_6 y - r_5 z - o\,w - o\,v = e_6$$
$$-r_6 x + (r_2 + r_2 r_6) y - o\,z - r_7 w - o\,v = e_7 - e_6$$
$$-o\,x - r_7 y - r_8 z + (r_3 + r_7 + r_8) w - r_3 v = e_3 - e_7$$
$$-r_5 x - o\,y + (r_4 + r_5 + r_8) z - r_8 w - r_4 v = -e_4$$
$$-o\,x - o\,y - r_4 z - r_3 w + (r_3 + r_4 + r_9) v = e_4 - e_3 - e_9$$

The value of any one of the unknowns can best be determined by the use of determinants, about which some of the rules connected with the elementary theory will now be given.

(*To be continued.*)

The Storage of Electricity.—Mr. W. Lynd, M.S.T.E., gave his second lecture on electricity at Bournemouth last week, dealing more especially with its utilisation for lighting purposes. He understood that at the Bournemouth refuse destructor there was running to waste enough energy, in horse-power, not simply to light the town and gardens with 25 3,000-C.P. arc lamps, but also in addition, to store up during the day sufficient power to light 200 16-C.P. incandescent lamps. Specimens of arc and incandescent lamps were on view during the evening, and accumulators and other apparatus lent by the Electrical Power Storage Company were also provided for the inspection of the company.

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* It will be seen that, although the direction of the arrow in the diagram is apparently clockwise, if outside space be considered as a mesh bounded by the conductors 1, 2 and 9 this arrow represents a counter-clockwise direction round it.

THE CONNAUGHT AUTOMATIC FIRE ALARM AND WATCHMAN'S DETECTOR.

A VERY complete combination fire alarm system has just been introduced by Messrs. Sharp and Kent. In this system the wires in connection with the fire alarm apparatus are utilised for the watchman's recording service, whilst the latter checks the condition of the fire alarm circuits, ensuring that at all times they are in perfect working order and ready for any emergency.

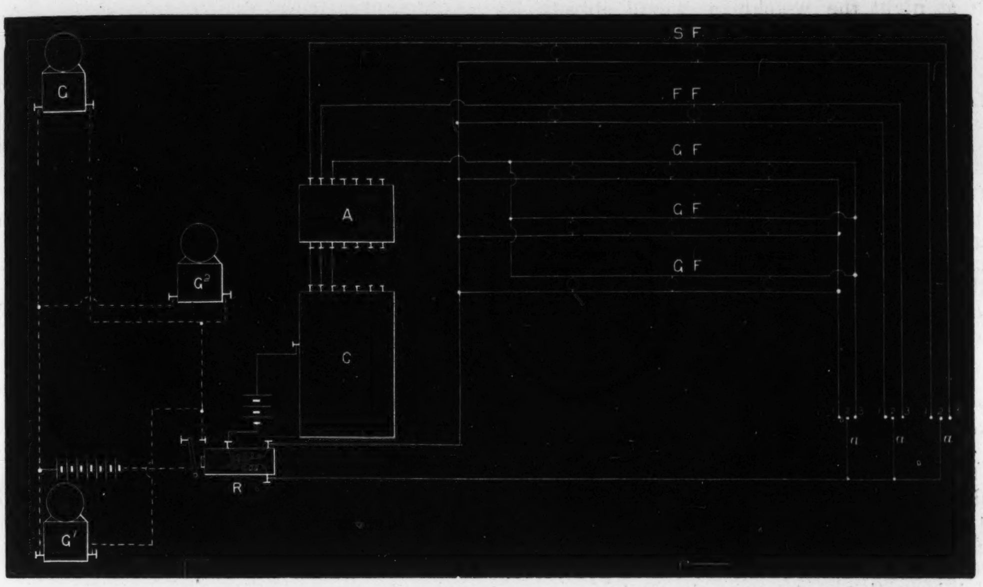


FIG. 1.

G, gong at fire engine station; G^1, gong in watchman's room; G^2, gong in office; A, annunciator; C, clock; R, relay; G F, F F, S F, ground floor, 1st floor, and 2nd floor.

The diagrams we give show the arrangements of the system.

The plant consists of a clock with a cylinder fitted with a time sheet, marked in hours and sixths corresponding to the clock time. The clocks are made to serve for from 5 to 40 stations, and are fitted with electro-magnetic actuating pointers which puncture the time sheets, one for each station. From the clock the wires are led to an indicator board and thence to the several fire alarm stations.

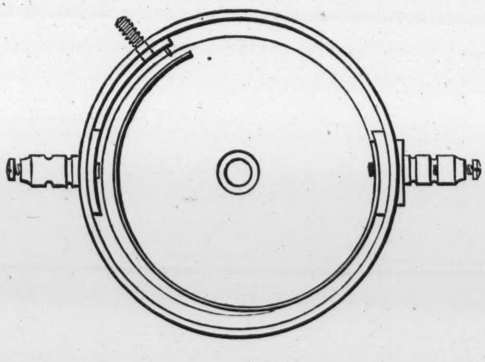


FIG. 2.

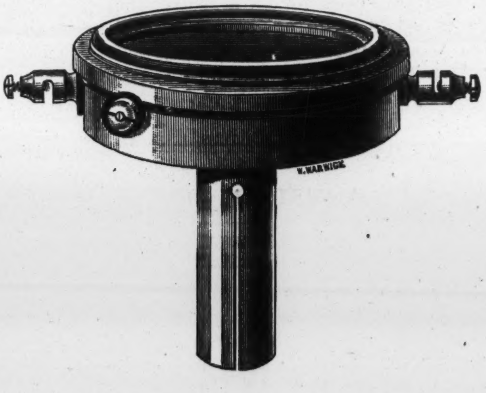


FIG. 3.

The thermostats (fig. 2) which give the alarm of an outbreak of fire are circular cases, in each of which is fitted a Bourdon spring containing a very small quantity of liquid hydro-carbon, which is extremely sensitive to heat. These thermostats are set to ring in an alarm at any determined temperature by means of a set screw. The effect of heat on these envelopes is to cause the expansion of the hydro-carbon, and the straightening of the spring referred to, thus making contact with the point and closing the circuit.

The thermostats are fitted to the ceilings of warehouses, stores, mills, asylums, &c., at 15 feet intervals. Each circuit is carried outside the building to a plug (*a*, fig. 1), into which the watchman presses a key hourly or oftener. In a warehouse a floor 100 feet by 45, along which three lines of wires would be run, may communicate with one indicator drop and be connected with a watchman's plug outside.

A return wire is connected to the thermostats, which wire is common to them and to the watchman's plug, and which before reaching the battery passes round the core of a relay. In addition to this the plugs have a third wire which leads from them to the relay, but is wound in the contrary direction to the first-mentioned wire. By this arrangement when the key is pressed in the three points, 1, 2, 3 are connected together, an indicator drop falls, and the time sheet on the clock is marked by the electro-magnet corresponding to that circuit, but the current passing both ways round the relay does not affect it.

Should, however, a fire break out or smoulder, the heat at once rises to the ceiling, causes the expansion very rapidly of the hydro-carbon in the thermostat, thus closing the circuit; in this case the current goes round the relay in one direction only, operates it and closes the gong circuit (marked in dotted lines) which has a separate battery.

One gong should be in the manager's office, another in the watchman's, or other suitable places; the indicator will at the same time show on what floor or division of a floor the fire is commencing. The building should also be connected to the nearest fire station, so that within a few minutes of the outbreak an engine would be on the spot, and the occupants of the building, or if at night the watchman, would already be trying to extinguish the fire.

The watchmen commence their rounds before the building closes for the night. Should any of the drops fail to fall, or the electro-magnets to record on the time sheet when he presses his key into the plugs, or should his action cause the bell to ring, there would be *prima facie* evidence that the circuits are not quite right. On the other hand, the plugging in of the keys by causing the record on the time sheet, and also the dropping of the indicator without ringing the bell, prove that all the plant is in order. These tests continue all night by the very act of the watchman recording their movements, and therefore one can say with confidence that the faithful overhead thermostats are ever wakeful, ever watching for the outbreak of fire.

Where a watchman is not employed the fire circuits can be tested hourly by an automatic circuit closer. A form of thermostat, shown by fig. 3, is made for journals to detect hot bearings. The tube is let into the metal, and should a certain temperature be reached, alarm is given of the locality indicated. Another application is in coal heaps, or other such places, where spontaneous combustion is possible; 3-inch iron pipes, each containing a thermostat near the foot, are placed at intervals of 15 feet, and give notice of extraordinary heat in the manner described above.

In large warehouses, where double doors divide the sections, it is desirable to know that they are closed at night. To ensure this, contact pieces are placed in each pair of doors, which only close the circuit when the doors are completely closed. In the manager's room is an indicator, with a drop for each set of doors and push buttons; before leaving, the manager presses all the buttons, and sees at once if all the doors are properly shut.

So successful has been this plant in the United States, that during the four years it has been in operation, there has been no claim made for fires which have commenced in buildings protected by it.

The whole apparatus (which is patented) can be seen in action at Messrs. Sharp and Kent's offices, Connaught Mansions, Victoria Street, S.W.

AMERICAN NOTES.

By DAS TELEPHON.

In telephone matters there is nothing new. The Supreme Court has not yet given its decision in the case of Bell, argued this time last year; it may be delivered on 20th inst.; if not at that time, it cannot be delivered before the 19th March, to which day the Court will adjourn on 20th inst. The principal question to be decided is as to the scope of Bell's fifth claim, which secures to him the exclusive use of an undulatory current for telephonic purposes. If that claim be sustained the Bell Company will continue to have the monopoly of telephone business in the United States, unless a telephone is brought out which operates on the make-and-break system.

The *World* newspaper of New York speaks as follows of the arguments of Col. Ingersoll :—

> Col. Ingersoll's eloquent and analytical argument before the Commissioner of Patents against the Bell Telephone conspiracy encourages the hope on the part of the over-taxed public that the iniquitous monopoly may yet be broken up. The re-opening of the patent case is asked for upon the most righteous grounds, and to refuse this plea now will go far to confirm the suspicion, so long prevalent, that the Bell Telephone Corporation is intrenched behind a triple plating of that metal against which "the strong lance of justice hurtless breaks." If Mr. McDonough is the rightful inventor of the telephone he ought to have a chance to establish the fact. That is all that is asked, it seems.

I wish to call the attention of those who intend to apply for patents in the United States to three facts which it is important they should consider well. The first is that an applicant must not expect that his application, prepared in strict compliance with the "Rules of Practice of the Patent Office" (copy of which I send you), will be accepted, for the reason that the Commissioner of Patents for the time being (usually a politician, and nothing more), changes the rules as it may please him. Nor are the decisions of Commissioners to be relied on as a guide, for the reason that each successive Commissioner decides matters for himself, and the present Commissioner has lately reversed all the former unanimous decisions of his predecessors. The second evil is that sometimes the officials of the Patent Office adopt a *theory* upon a certain line of invention and repel all applications which do not conform to that theory, and the effect is that the Patent Office arrogates to itself to say to the inventive mind of man: "thus far shalt thou go and no farther." A third evil is that the Examiners who are to decide upon inventions emanating from the greatest scientists of the age know absolutely nothing of the principles upon which they are called upon to pass judgment. I cite as one case that of the Examiner of electrical matters. He was last year an Examiner of water-closet machinery, and was transferred to the electrical department in March last. What can he know of the science of electricity!

Cyrus Field is again at his old tricks — about a cable to the Sandwich Islands. In 1871 this cable jobber applied to Congress for a subsidy of $500,000 per annum for 20 years for a cable between San Francisco and China. He urged the necessity of such a cable—especially for the use of our navy —and as a reason for asking such a subsidy, he stated before the Committee of the Senate that no cable then laid (1871) had paid a dividend. I was present on that occasion, and at the next meeting of the Committee I laid before it a letter signed Cyrus Field, published in the *Times* of London, in which he gave a glowing account of the profit derived from the cables then laid, showing that they paid over 25 per cent. dividend per annum. This exposure put an end to his attempt to get a subsidy. The following is from an influential newspaper :—

> The aid of Congress is to be sought in laying a submarine telegraphic cable from San Francisco to the Sandwich Islands, with a view to its ultimate extension to Japan. This undertaking seems to belong to the domain of private business enterprise. The ground on which public assistance is sought is that if ever we should be at war with a foreign power and a hostile fleet should assemble at Honolulu for the purpose of attacking our Pacific coast the cable might give earlier warning of this purpose than could otherwise be had. This elaborate series of hypotheses recalls the extra-prudential reasoning which led to Mrs. Toodle's purchase of her famous door plate. Canada and Australia are now planning an intercolonial submarine cable for the Pacific, and the strategic value of this line is perhaps more obvious. There is quick communication now between the western coast of the United States and the eastern coast of Asia by going the longer way round the globe, and our trade with the Sandwich Islands is too limited for private capital to risk the cost of a cable for its transaction.

At a recent meeting of the Electro-Automatic Transit Company of Baltimore City, it was decided to build a test line for the rapid delivery of newspapers, mails and express matters generally. The mechanical contrivance, under the new system of rapid transit, invented by David G. Weems, and controlled by the above company, hopes to revolutionise the world in this respect. It is very simple, consisting of a light structure, elevated some 20 feet from the ground, thereby offering no hindrance to the cultivation of fields over which it may pass. Cars, pointed at both ends, are run on two tracks, having also an upper or third rail which acts in the twofold capacity of a guide rail, and the conductor of the electric current. Each car is provided with an upper or guide wheel at each end, whose flanges enclose the upper or guide rail on each side, thus rendering the jumping of the track a matter of impossibility. The motive power consists of a permanent generator of certain prescribed horse-power, located at each end of the line, from which the current passes to the conductor rail, where it is immediately taken up by the travelling motor, to which one or more cars may be attached. The whole train is automatic in its action, each car springing its own brakes in succession in passing a permanent trip lever, located at a sufficient distance from the stopping place, after the train has already passed a point where the electric current has been cut off permanently, leaving the train to its own momentum only, when the brakes are automatically applied.

A decision has been rendered by the First District Court of Mexico affirming the validity of the Bell telephone and Blake transmitter patents under the laws of Mexico. The defendants in the case, a German mercantile house, are ordered to deliver their stock of instruments to the Mexican Telephone Company, to make a statement of their profits and hand them over, and to pay all the costs. The defendants will appeal to the Supreme Court.

Memorials and petitions flow into Congress to establish a postal telegraph. At a meeting of the National Board of Trade, last week, in this city, the "Postal Telegraph" was the first subject taken up on the regular programme. Mr. F. B. Thurber, of New York, spoke in favour of the Post Office Department assuming charge of telegraph communication. He read a letter from Kenric B. Murray, secretary of the London Chamber of Commerce, replying to certain questions previously submitted by Mr. Thurber. The letter says the result of the purchase and operation of the telegraph by the Government has been successful as far as service is concerned, but not financially to the Post Office. The increase in the number of *employés* in the Post Office Department has not been productive of political evils worthy of note. The overwhelming, almost unanimous, sentiment would be in opposition to the return to private management. Mr. Erastus Wiman, of New York, spoke in opposition to Government control. He said that in the British Post Office report of 1887 the table of receipts and expenses for the year 1880-81 to 1886-87, inclusive, shows a steadily increasing deficit, amounting during the last fiscal year to over two million three hundred thousand dollars. To meet this loss the whole population is taxed to afford a cheap telegraph service to the very small percentage of the population that ever use it. After further discussion it was resolved, "That the usefulness of the Post Office Department should be extended in the direction of telegraphic communication, and we urge upon Congress the earliest favourable consideration of this question."

I do not think that there is the ghost of a chance that a postal telegraph will be established by Congress. I may say in reference to this subject that G. G. Hubbard, father-in-law of Professor Bell, is advocating such a project, and it is alleged that the Bell Telephone Company is stretching out wires between numerous distant places, with, it is said, the purpose of establishing a telegraphic-telephone service.

I send you an interesting account of an electric railroad, and also the several Bills relating to postal telegraphs introduced into Congress.

Washington, *February 17th*, 1888.

The Académie des Sciences.—MM. Deprez, Bertrand, Lévy, Mascart, and Becquerel have been nominated by a ballot of the Académie to act as judges for the *Grand prix des sciences mathématiques* for the present year. The subject chosen for the prize is, as our readers know, "The perfecting in some important points the theory of the application of electricity to the transmission of power."

GLASGOW CITY HALL AND BAZAAR

THE following gives some details of the Thomson-Houston installation at the Glasgow City Hall and Bazaar, just completed under the supervision of Mr. Wm. A. Bryson, engineer and electrician to the Glasgow International Exhibition.

Description of Installation.

The installation consists of a Robey multitubular boiler of the loco type supplying steam to a Robey horizontal compound high pressure engine, driving by leather belts from a broad flywheel direct on to two Thomson-Houston dynamos. The dynamos are fitted with all the Thomson-Houston patent self-regulating apparatus, to keep a constant current and allow any number of the arc lamps to be switched out or in as required, without alteration of speed of engine, or special attention at dynamo and regulating the power required in proportion to the number of lamps in use at any one time. This is a special feature which is peculiar to the Thomson-Houston arc light in series system. The lamps are arranged on two circuits, one circuit being supplied by each dynamo, with every alternate lamp on a different circuit, so that each dynamo gives an equally distributed light all over the Bazaar and City Hall. In the Bazaar there are 23 double Thomson-Houston arc lamps fitted with enamelled reflectors, and 10 double Thomson-Houston arc lamps in City Hall, fitted with ornamental coronas and suspended from the roof of the hall by silk covered cables with eight incandescent lamps in two groups of four each under the back gallery of the hall.

In the engine and dynamo room, which is under the bazaar at the corner nearest the police office, there are four cut-outs fitted so that one-half or all the lamps in either the City Hall or Bazaar can be switched out from there when required, and every lamp has its own independent switch. The installation has been fitted for the Corporation by Mr. Richard Miller, sole agent in Scotland for the Thomson-Houston system, under the supervision of Mr. W. A. Bryson, superintending engineer.

The official test took place on Friday last and was for six hours, but owing to a ball which was being held in the hall the contractor, as more fully explained in our "Notes," continued running the City Hall circuits until 3.30 in the morning. Everything went in a very satisfactory manner, and the members of the committee expressed themselves highly satisfied.

LEGAL.

The Faure Electric Accumulator Company, Limited v. Phillipart. – In the Queen's Bench Division on Monday Mr. Justice Hawkins delivered judgment in this case, heard last week. He said that the articles of association provided that the board should consist of not less than three directors, of whom two should be a quorum. It appeared that the board had become reduced to two directors, of whom the defendant was one. These two held a meeting, passed a resolution to increase the board to five members, named three gentlemen, who at once accepted the position, and the board thereupon made the second call. It might be that the two directors had no power to reconstitute the board, but the defendant himself was in the chair when the second call was made and when the shares were forfeited, and he was therefore estopped from disputing the validity of the call so made. In his opinion the defendant had established no legal answer to the claim for unpaid calls, but he had established an answer as to a large part of the interest claimed. There would, therefore, be judgment for the plaintiffs for the amount of the calls, £49,064, together with interest upon the first call from the 6th December, 1882, until the 3rd January, 1883, the date of the forfeiture, which interest amounted to £204. The judgment, therefore, would in all be for £49,268. Judgment for the plaintiffs.

Edison and Swan United Electric Light Company v. Shippey Brothers.—An application was made in the Court of Appeal on Wednesday last by the above company to dismiss Messrs. Shippey Brothers' proceedings for a new trial or the re-hearing of the case, on facts previously stated. It may be remembered that the Court made an order in December last that the defendants should pay into Court a certain sum of money to secure costs of the appeal case. Mr. Arthur Shippey again conducted his own case, and stated that he was quite prepared to comply with the order of the Court, but the plaintiffs had garnisheed the sum of £8,000 in cash and shares payable to him by his company, which had prevented him from complying with the order, besides causing considerable annoyance to his firm; in fact, it had prevented the company going to allotment of shares. Mr. Shippey disputed the right of the plaintiff company to make the present application, alleging that the company had no legal estate in Edison's patents whatever, and said he should, if allowed to amend the pleadings, contest the validity of the patents on several grounds. He pleaded as a bar to these proceedings that no deed or document signed by an American citizen, if such deed was executed in the States, could be legally used in an English Court to operate against a British subject; and that as Mr. Edison was an alien no legal estate could vest in the company, whose title was bad on the face of it. Lord Justice Cotton intimated that these points of law would be arguments for decision at the trial, but the question before them then was to decide as to the order for the security of costs being complied with prior to the granting of a new trial of the case, which could not on go indefinitely. At the same time, he considered the plaintiffs somewhat premature in making the present application, and upon Mr. Shippey undertaking to comply with the order as to security for costs the Court granted him a month's extension of time to complete his arrangements, and refused the plaintiffs' application as to the costs of the day.

NOTES.

Bournemouth and the Electric Light.—On Monday evening last week a meeting was held at the offices of Mr. John S. Helyer, surveyor and architect at Bournemouth, having for its object the formation of an electric lighting company. Mr. Helyer briefly described the objects of the proposed company, lucidly explained the system to be adopted, and mentioned that arrangements had been made with Messrs. Ferranti and Ince for the purchase of the requisite plant The provisional prospectus was placed before the meeting and, subject to the supervision of the solicitor and committee, was adopted. For further particulars we refer our readers to the list of new companies registered.

Lighting of the Leeds Fine Art Gallery.—The Electric Lighting Committee of the Leeds Corporation met last week to consider what form of power should be employed for driving the dynamos in connection with the electric lighting of the Leeds Fine Art Gallery. After discussing the respective claims of steam, gas, and compressed air as motive powers, it was decided to adopt the latter, as being generally more suitable for this particular purpose; as getting rid of risk from fire; as obviating the use of fires, boilers, and long chimneys, and as being of service in connection with ventilation. It was therefore decided to accept the offer of the Compressed Air Company to supply compressed air, and also to furnish five 25-horse-power engines and a meter, at a rental of £50 per year for three years.

Exeter and the Electric Light.—At the last meeting of the Exeter Town Council, Mr. Williams gave notice that at the next meeting he should move "That the Town Clerk do prepare a return showing what water power we have disposed of to private companies or individuals, and what we now retain on the river, in order that we may afford every facility and help forward, as a Council, the objects of the public meeting held at the Victoria Hall on Tuesday night under the presidency of the Mayor." An account of this meeting, which was held to advocate the adoption of the electric light, appeared in our last issue.

Train Lighting.—We hear that the Brighton and South Coast Company is about to make, or has quite recently made, experiments with a system of lighting trains electrically different from that which has been in vogue in some of its trains for some considerable time.

Kensington and Electric Lighting.—At the Kensington Vestry meeting last week, Mr. John Braye moved, "That this Vestry, in the interest of public safety and economy, apply to the Board of Trade for a licence, under the Electric Lighting Act of 1882, for the right of supplying the whole parish of St. Mary Abbotts, Kensington, with electricity for lighting and other purposes, and for powers to transfer or lease any portion of the rights and privileges conveyed by the licence." This was agreed to.

The Premier and the Electric Light.—According to the *Star*, during the recess Lord Salisbury has had electric lights introduced into the saloon and in the dining room of his house in Arlington Street, which adds much to the brilliant effect of his receptions.

The Electric Lighting Act.—Mr. Barclay asked the President of the Board of Trade in how many cases the powers obtained by provisional orders under the Electric Lighting Act of 1882 had been actually exercised; whether he could inform the House why so little progress had been made with electric lighting under the Act of 1882; and whether the Government intended to amend the Act, with the view of encouraging the development of electric lighting. Sir M. H. Beach said: Since the passing of the Electric Lighting Act 59 provisional orders and 5 licences have been granted to companies, and 15 provisional orders and 2 licences to local authorities. The Board of Trade are not aware of any case in which the powers obtained are now being exercised. It is not possible to express an opinion as to the reasons which may have led to this result within the limits of a reply to a question. A Bill to amend the Act has been introduced in another place, on which the views of the Government will be stated and the issues fully discussed.

The Prince and the Electric Light.—According to the *Globe*, the Prince of Wales has recently decided to have the State apartments and principal rooms in Marlborough House lighted by electricity, and it is expected that all the necessary apparatus will be fixed in time for the silver wedding celebration early this month. The work is in the hands of the officials of the Prince's household, who are assisted by a special staff directed by Mr. T. O. Belshaw and the Court electrician, Mr. Massey. The current will be supplied by the Grosvenor Gallery Company, whose wires now run close to the War Office in Pall Mall.

New Zealand and the Electric Light.—The Council of the City of Wellington, New Zealand, invites tenders for the lighting by electricity of the streets and public places of the city. The Corporation, having a full and ample water supply from two distinct sources, will supply the contractor, free of charge, with water for two high-pressure turbines, each of 30 horse-power actual. The specification contains certain provisions relative to the supply of electricity for lighting and for motive power to private individuals. Full specifications and conditions, plans and photographs of the city, and other documents and written information can be seen at the office of the Agent-General of the Colony in London, 7, Westminster Chambers, Victoria Street, S.W.

The Electric Light in Flour Mills.—The Buckingham Flour Mills, belonging to Mr. A. C. Rogers, have been fitted with the electric light. The dynamo is of the Elwell-Parker new type, and is driven by water-power from the mill shaft. The interior of the mill is brilliantly illuminated by means of Edison-Swan incandescent lamps of 16 to 20-candle-power, fixed in white enamelled metal shades set close to the ceiling. there is also a movable lamp fixed in a lanthorn, which by means of a flexible silk-covered wire cord may be used for stone dressing, examining the machinery of the mill, and also to illuminate the bins, where a light is not always required. The contract has been carried out by Mr. W. Habgood, of West Dulwich.

House-to-House Electric Light Supply Company.—It is said that this company has applied to the Kensington Vestry for permission to lay wires under the roads in the parish, the application being supported by over 1,000 of the most influential householders, who desire to secure the benefit of the electric light.

"The Dog in the Manger."—Under this heading we notice the following paragraph in a Sunderland paper:—"We are sorry to learn that the Postal Authorities have, from some unexplained cause, taken a sudden dislike to one of the Northern District Telephone Company's public call offices, and much annoyance is likely to be caused to the inhabitants of Roker by their arbitrary action. The Authorities give no facilities to the residents in that portion of the borough, either in the way of telegraphic or telephonic service, but the shop occupied by Mrs. Taylor in St. George's Terrace has for some time been used both as a post office and a public telephone call office in connection with the Northern District Telephone Company's system. The Postmaster, we understand, has given Mrs. Taylor peremptory notice that she will not be allowed to retain the telephone business together with the business of the Post Office."

Submarine Cables.—The House of Representatives at Washington, passed the Submarine Cables Protection Bill last Friday.

Mexican Customs Dues.—It is officially announced that the Mexican Government has decreed that all wire, instruments, &c., intended for telegraph and telephone lines shall pass through the Mexican Custom Houses free of duty.

The Australian Cable Scheme.—The *Globe* had the following mysterious paragraph in its issue of Wednesday last:—"With a view to laying the proposed new Australian cable, soundings are being taken by order of the Colonial Governments in the Pacific Ocean. The proposed route is along a track where, up to the present, no cable has been laid. The cable is one with which Mr. Henniker Heaton, M.P., will be officially connected, and it will receive subsidies from the Colonial Governments interested." We should much like to know where our contemporary got its information, for we have strong doubts as to its accuracy.

The Electro-Motor.—F. L. Pope contributes to *Scribner's Magazine* for this month a clear account of the origin, development, and present state of perfection of the electro-motor, with its applications to various industries. The historical part of the article is illustrated with drawings of some of the first electro-motors. A number of portraits of the men who did so much toward the application of electricity as a motive power—such as Ampère, Arago, Joseph Henry, Charles G. Page, and Siemens—are also among the illustrations. Mr. Pope, in the latter half of his article, describes the present use of electro-motors to propel street cars, freight tramways, elevators, sewing machines, &c. These applications are shown in the illustrations. Altogether the compilation is a capital specimen of a magazine article.

Phœnix Fire Office Rules.—The 12th edition of these famous electric lighting rules and regulations is now ready, and the rapidity with which edition succeeds edition is a proof of the value which is generally attached to them. Nothing of importance has been added since the date of our former notice, in which, it will be remembered, transformers figured conspicuously.

Royal Society.—The following papers were down to be read yesterday afternoon. Shelford Bidwell, F.R.S., "On the changes produced by magnetisation in the dimensions of rings and rods of iron and some other metals." Prof. Schäfer, F.R.S., (1.) "On electrical excitation of the occipital lobe and adjacent parts of the monkey's brain."

Transmission of Power in Madrid.—The Madrid newspaper *El Economista* announces that attempts are being made to form a company for the supply of the electric light and motive power, employing for these purposes hydraulic force derived from the river Manzanares. It is calculated that 2,700 horse-power can be obtained at the river, and allowing for the loss in transmission and in conversion to mechanical power, it is assumed that an equivalent to 1,350 horse-power can be made use of. The present price per horse-power with gas engines is 50 centimes, and it is stated that the new undertaking can supply the same power at 25 centimes. The same amount of light as produced by gas at 5 centimes per hour can be given, it is said, by the new venture at 2½ centimes.

Electrostatic Attraction in Liquids.—In a note by M. Gouy to the Académie des Sciences, the author states that he has found that the attraction between two electrodes kept at a constant potential is far greater when these electrodes are immersed in a liquid than when they are in air; the attraction of a disc 87 millimetres in diameter placed in distilled water above a large surface of mercury, the disc and mercury being connected with the poles of an 8-cell bichromate battery, was found to vary as the square of the distance below the surfaces, and to be at least 100 times as great as the attraction in air. The exact cause of the phenomenon seems doubtful.

Correction.—Mr. Mackenzie (not the newly-appointed Principal of the R.A.M.), writes to say that fig. 18 of his paper was printed in our last issue upside down, and he requests us to make a note thereof. We do so with pleasure, although we think the fact was pretty evident to all who perused Mr. Mackenzie's article.

The Fool's Paradise.—At the annual meeting of the Portsmouth Gas Company on Saturday (which was held with closed doors), the usual fat dividend was announced, with a larger one in prospect six months hence, and Mr. H. C. Ward, of London, is reported to have said in reference to the local Electric Lighting Company which has been mooted, that while a 1,000 feet of gas at 2s. 6d. was equal to 7s. 6d. worth of the electric light, the public were hardly likely to go in for the new illuminant. The inference is quite true. We regret our inability to say as much for the hypothesis on which it is based. Evidently Mr. Ward has never heard of Taunton.

The New ss. "Amber."—The new telegraph cable steamer *Amber*, the fifth vessel for a similar purpose which has been built and engined by Messrs. R. Napier and Sons, Govan, for the Eastern Telegraph Company, proceeded down the Clyde last week on her official trial. The *Amber* is the smallest vessel of the fleet which has been built by Messrs. Napier for this company, but internally her space has been so utilised that she may be appropriately designated a *multum in parvo* of those which have preceded her. The dimensions of the steamer are as follows:—Length, 210 feet; breadth, 31 feet; depth, 24 feet; her tonnage (builders' measurement) being 978 tons. The hull is of steel, and the vessel is classed 100 A 1 at Lloyd's (special survey). Besides the usual fittings of a first-class vessel, all the most modern improvements have been introduced to make the steamer efficient for her special work. The vessel has been designed and built under the superintendence of Mr. Joseph Birnie, London, and the machinery has been constructed under the inspection of Mr. A. Beldam, London. On several trials over the measured mile yesterday a mean speed of about 13¼ knots an hour was obtained—a remarkably good result considering the length of the vessel and her unequal trim, caused by the absence of her telegraph machinery, &c.

Late Letters.—We have received some comments upon Mr. Addenbrooke's last article, but they reached us too late for insertion in this issue of the REVIEW.

Electric Railways.—Herr Fischer, a civil engineer of Vienna, has obtained a concession for an electric railway between Vöslau and Rauhenstein, near Baden, and from there to Leopoldsdorf. The length of the line being considerable, Herr Fischer will probably use storage cars, says *Industries*. Julien accumulators are now being tested in the Electrotechnical Institute, and a trial of these cells for tramway work in competition with Reckenzaun cells will shortly take place.

Engine Trial.—The engine for the lighting of the Bazaar and City Hall at Glasgow with the Thomson-Houston system, which is a 16 H.P. compound, was made by Robey & Co. Previous to the official test it was running under brake from 9 a.m. till 4.45, when it was stopped to put the machine belts on, and at 5 o'clock was started again for the official test of six hours, all lamps (34) on. At the expiry of the six hours all the bearings were quite cold. One-half of the lamps (*i.e.*, those in the Bazaar) were thrown off, and the remainder were kept going till 3 a.m. on the 25th inst. for a ball which was being held in the City Hall. The engine, therefore, had a continuous run (except the 15 minutes for putting on belts) from 9 a.m. one day until 3 a.m. the next. The oiling arrangements are most satisfactory, and with them there is nothing to prevent continuous runs for an indefinite time. The governor acted perfectly when the half load was thrown off, and there was no perceptible change in the engine speed. The whole installation is by far the most complete and satisfactory one that has ever been started in Scotland. The present load on the engine is only the 34 lamps, but six more will probably be added shortly; there is, however, power enough to drive 10 or 12 more without overloading the engine.

Theatre Fire.—The Union-Square Theatre in New York was burnt to the ground on Tuesday afternoon, and about $8,000 worth of theatrical properties was destroyed.

A Graphic Price List.—A novel plan has been adopted by the firm of A. B. Gill & Co. to enable purchasers to at once ascertain the price of any of their dynamos. It will be seen that it consists of a curve of prices and a curve of speeds, showing at a glance that prices are nearly proportional to output, but with an advantage in favour of the purchaser as the size increases. It is claimed that the curve possesses an advantage over an ordinary price list in the matter of conciseness, information which would occupy pages in a catalogue being here shown at a glance. The authors seem to have considered their design possessed of sufficient merit to induce them to register it.

Worth Having.—A glance at the official returns of electrical companies, which we publish this week, reveals the fact that Mr. Courtenay is a lucky man, and the company retaining his invaluable services will, doubtless, be thought a prudent one. Till now we had not the faintest idea that going abroad so enhanced the value of one's services at home. And yet there are some people who think that a managing directorship is not everything that could be desired.

Paris Exhibition.—The London Committee met at the Mansion House on Wednesday, when an Executive was formed, and the following contributions to a guarantee fund were promised:—The Lord Mayor, £500; Chubb and Sons, £500; Mr. Sheriff Davies, £250; Mr. Hawksley, £250; Mr. Aird, M.P., £500; Mr. Ernest Hart, £100; and Sir Daniel Cooper, £250.

Personal.—It is stated that Sir John Pender's friends are arranging for his portrait being painted by a distinguished artist, with a view to its presentation to Lady Pender.

We are glad to announce that Mr. W. A. Bryson, Engineer and Electrician of the Glasgow International Exhibition, has had entrusted to him, the work in connection with the electric lighting of the Public Library at Edinburgh.

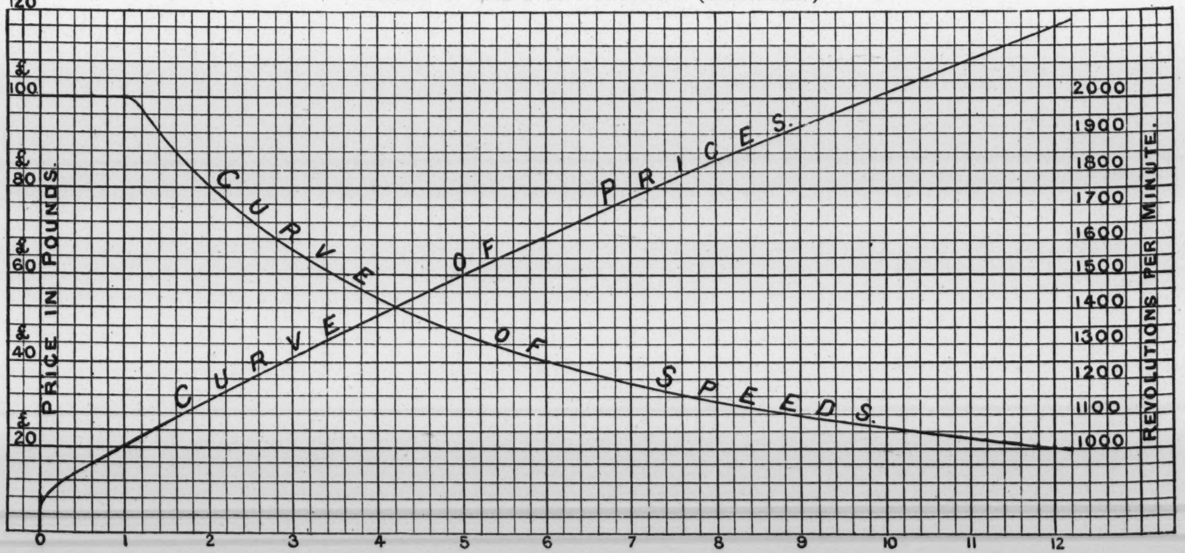
The *Argosy*, of Georgetown, Demerara, speaks thus of a new arrival:—"The new Electrician for our Postal Department—Mr. Vyle from Glasgow—has arrived and begun work. He has come to a land where he will find an immense number of his family, only they all spell their names differently. I hope to be able to write of him—

The Chief he never teases.
Benign and void of guile
He all the public pleases,
His name alone is Vyle."

The Electro-Harmonic Society.—At the concert to-night, Mr. Spagnoletti, C.E., Past-President of the Society of Telegraph-Engineers and Electricians, has kindly consented to take the chair. In the whole course of our experience we cannot recall to mind a programme of a more varied and excellent character, when we consider that the brunt of the entertainment will be borne by amateurs. We trust that the artistes, one and all, may do themselves justice, for if this proves to be the case, there is no reason why the "amateur night" should not become one of the regular features of the Society's concerts.

U.S. Patent Office.—We have received a copy of the tenth edition of the Rules of Practice in the United States Patent Office, revised to March 9th, 1887.

ARTHUR B. GILL & CO.'S DYNAMOS.—(REGISTERED.)



Opposition to Overhead Wires.—The bill deposited by the United Telephone Company, seeking powers to erect overhead telephone wires within an area of 12 miles from the General Post Office, has called forth opposition of a most formidable character, no fewer than 54 separate petititioners praying to be heard by counsel against the proposals. Among this number are the Corporation of London, the Metropolitan Board of Works, 21 of the local authorities around London, all the railway companies in the metropolis, with the exception of the Underground Lines, 14 private corporations, and all the London Water companies.

Friction Couplings.—In an illustrated price list issued by Messrs. J. Bagshaw & Sons, of Batley, will be found some interesting particulars of the nature and uses of friction clutches, a subject of special interest in connection with electric light machinery. This firm has also devoted considerable attention to the production of a true running wrought-iron pulley for electric lighting purposes, and in the same catalogue give descriptions and prices of these also.

Electric Tramcars.—At the Brussels Exhibition electric tramcars will be used throughout the buildings and annexes. The weight of these cars is 33 cwt. each, including passengers, and they are intended to be run at a speed of 4 to 5 miles per hour; rather more than 1-horse-power is required for their propulsion. The accumulators are of the Somzee type, and weigh about 6 cwt., 40 cells being employed, each fully charged, weighing about 16½ lbs. The motor and gearing weigh about 5 cwt.

The Society of Telegraph-Engineers and Electricians.—The next meeting will be held on Thursday, March 8th, 1888, when a paper on "The Present State of Fire Telegraphy" will be read by R. von Fischer Treuenfeld, member.

Where is that Dynamo?—There appears to be a mystery in Sydney, regarding a certain "Gulcher electric light apparatus," which was bought by the New South Wales Government for, it is stated, £1,900 in 1884. It was stated to be in the Government Stores, but neither the storekeeper nor anybody else knows where it is now. There are accusations of underhand dealing in connection with the sale and purchase of the dynamo, as well as with its disappearance.

Paris Central Laboratory.—*La Nature*, of the 25th ult., contains a capital page illustration, with description, of the Central Laboratory of Electricity at Paris. The article is signed "E. H.," sufficient guarantee that the subject is adequately and interestingly treated.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

United Telephone Company of Rosario, Limited.—The statutory return of this company, made up to the 2nd December, 1887, was filed on the 27th February. The nominal capital is £20,000, in £10 shares. 937 shares have been allotted, and are considered as fully paid.

Electrical Power Storage Company, Limited.—An agreement of 23rd ult. (filed 27th ult.), cites that Mr. J. Irving Courtenay, having refused to accept an offer made to him by the largest company in New York carrying on similar business, for the employment of his services, the directors of this company have agreed to retain his services as managing director for four years at a salary of £1,250 per annum, together with 5 per cent. of all such shares or royalties on the sale or license of the company's British and foreign patents, under contracts entered into during his employment as managing director. As a bonus, 2,000 fully paid shares are to be allotted to Mr. Courtenay.

Taunton Electric Lighting Company, Limited.—The annual return of this company, made up to the 20th ult., was filed on the 25th ult. The nominal capital is £10,000, in £5 shares. 873 shares are taken up. 664 shares are considered as paid up, and £1,045 has been received in respect of the remaining shares.

Laing Electric Light and Power Company, Limited.—The annual return of this company, made up to the 20th February, was filed on the 23rd ult. The nominal capital is £1,000,000, in £10 shares. 1,207 shares have been allotted, and of these, 12,000 are considered as fully paid. Upon the remaining 7 shares the full amount has been called, but the call has not been responded to.

Atlas Electric Appliances Company, Limited.—The annual return of this company, made up to the 20th February, was filed on the 23rd ult. The nominal capital is £2,000, divided into 500 founders' shares and 1,500 preference shares of £1 each. 707 shares have been taken up, and the full amount has been called thereon. £700 is considered as paid upon 450 founders' shares and 250 preference shares. The total of the calls unpaid is £7.

NEW COMPANIES REGISTERED.

Bournemouth Electric Light and Power Company, Limited.—Capital: £4,000 in £5 shares. Objects: To supply approved renters in Bournemouth and neighbourhood with electric light and power. Signatories (who are all of Bournemouth, and subscribe 1 share each): F. J. Bright, J. Donkin, J. J. Allen, H. Hammond, P. W. G. Nunn, E. P. Fippard, J. S. Helyer. Registered office, 25, Old Christchurch Road, Bournemouth. Registered 23rd February by Peacock and Goddard, 3, South Square, Gray's Inn.

Gülcher (New) Electric Light and Power Company, Limited.—Capital; £70,000 in £1 shares. Objects: To acquire the business property and goodwill of the Gülcher Electric Light and Power Company, Limited. Signatories (with 1 share each): *Lt. Col. A. Hornsby Drake, 12, Prince's Gardens, W.; *Daniel de Castro, Mortlake, S.W.; *Wm. Wallace, 29, Old Bond Street; *R. Pryor, 79, Gracechurch Street; *H. Grewing, 14, Austin Friars; *Gustav Binswanger, 5, Great St. Thomas Apostle, E.C.; *T. Lloyd, 40, Hogarth Road, South Kensington; *H. Lane, Palmerston Buildings. The signatories are the first directors. Qualification: 50 shares. Remuneration: £750 per annum, or such larger sum as shall be equal to 10 per cent. per annum of the net profits, not exceeding £1,500 in any year. Registered 28th February by Trinders & Co., 47 Cornhill.

CITY NOTES, REPORTS, MEETINGS, &c.

The Swan United Electric Light Company, Limited.

THE fifth ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel on Tuesday, when Mr. J. Staats Forbes, the chairman of the company, presided.

Mr. Gover, the assistant secretary, having read the notice convening the meeting,

The Chairman, after explaining the absence of the secretary, Major Flood Page, who had been sent on a special mission to Berlin, said the debtor side of the profit and loss account would show the relative state of things in the year to September 30th, 1886, and the year to September 30th, 1887. He might incidentally remark that a short time ago they made their year end on September 30th instead of June 30th, for the reason that the Edison-Swan Company of Britain, in which they were largely interested, made up its accounts to June 30th, and when the happy moment arrived when that company would distribute a dividend, the Swan Company would participate largely, and it would be shown in the subsequent accounts. On October 1st, 1886, they carried into stock lamps to the value of £8,945 6s. 2d., a diminution of about £1,600 on the value of the stock of the previous year. It was an advantage not to have too great an amount of money locked up in stock-in-hand; but from the nature of their business they must have a considerable number of lamps manufactured and ready to be delivered. Purchases, that was the cost price of the materials necessary to produce a lamp, amounted to £6,795 against £4,763 in the previous year. Wages and expenses in the factories, £7,839 12s. 8d. as against £7,932 15s.; depreciation, £2,147 11s. 2d. against £3,000 last year; directors' fees, salaries, &c., £3,733, against £2,267; balance of profit on the year, £7,554 11s. against £4,768. On the other side were, sales, less commissions and allowances, £27,128 10s. 10d. against £22,000; transfer fees, interest, &c., £1,665 6s. 7d.; stock carried forward £8,221, against £8,945. They conducted their business on a principle which was well known in and about Birmingham, on the principle of a standard price, which was diminished according to the number of lamps sold. The sum of all this was that the business had progressed in a fashion which, after charging the revenue very liberally on depreciation, showed an increase of profit from £4,700 to £7,500, nearly £3,000. That was a very large profit, and not an unsatisfactory one. The capital account was made up of two elements, the element of value represented in the foreign business, of which the profit and loss account was the outcrop, and the element of value made up in the large holding of the company in the Edison Company in England. They would see by reference to the balance sheet that they held £208,500 in that company, about which he would say a word or two. The business of the year shown in the last accounts showed a profit of £16,000. The capital was £470,000, of which £117,000 was in deferred shares. That £16,000 would have been available for the payment of a dividend upon the fully paid "A" shares, £85,000, and upon the part-paid "A" shares £276,783, but for the antecedent history of the company. The profit and loss account having shown an accumulated loss, they made up their minds that before there could be any distribution of profit the loss of anterior years must be paid off. That loss was now wiped out. Going back for a moment to their own accounts, they would see that the directors proposed in the same way to devote the balance of profit to wiping out the losses of previous years, when they would be able to start clear with a balance in their favour for the current year. Therefore in both companies they had arrived at the moment when they had paid off the encumbrances resulting from losses in previous years, and were both in the position that if there should happily be any profit to divide, it would be in the discretion of the proprietors to divide it. Concurrently with that, there was the fact that in both companies they were progressing with the sale of the article. He supposed it was becoming pretty apparent now, notwithstanding the obstruction thrown in the way of electric lighting by legislation, by litigation as to patents, and by the slowness with which such things make way, especially in countries where gas was available at a very low rate, as it was in England, that the electric light was coming rapidly to the fore. Everybody heard now of installations being put up in theatres, in clubs, in public buildings, and in private houses, and he supposed they might assume now that this thing would go on and spread very rapidly. The difference between the Edison Company of Great Britain, in which they were largely interested, and the Swan Company abroad, in which they were also largely interested, was this: they had succeeded, as the result of litigation, in establishing their claim to the patents in Britain. They had had many fights, one of which, with Woodhouse and Rawson, they had just won on appeal on all the points, and they were now, subject to that decision being over-ruled, the absolute owners of every incandescent lamp in Great Britain. Abroad the position was not quite so settled or so advantageous. They had had litigation, which had dragged on a very long time, and had arrived so far as it had gone, at no conclusion; it was all *in nubibus* still. There had been decisions adverse and decisions favourable; at present they were more or less in the clouds. They were still going on manufacturing lamps, and the accounts before them showed the result of the year's business done under these circumstances. What was prudent and reasonable for them to do? They had tried to do abroad what they had done at home with such advantage, because he would undertake to say that if the Swan Company and the Edison Company in England had gone on litigating there would have been no such thing as the £16,000 of profit last year, nor in any year as long as the litigation continued; but they had put their horses together, and were strong in the unity of the two companies, and strong against the rascality of infringers. He was in hopes that he might have been able to announce at that meeting that they had arranged some sort of treaty or agreement with the foreign companies. They had had communications in Paris with the French Edison Company, who were contesting with them in France for the right to sell lamps, and in Belgium, Austria, and Russia, and they had come to something like a basis of arrangement with that company, under which it was proposed that they should become partners. That was to say they put all their assets into one pot and divided the profits in agreed proportions. The parties were willing, but unfortunately Mr. Edison's friends seemed to have made some very loose agreements, and the freedom of the French Edison company and its power to deal with the matter was in some measure interfered with by the complications of those agreements. One of the principal suits was going on in Germany. We heard of delays of law in England, and we grumbled at it; if it was any consolation to know it, the delays in Germany were still more awful. These patent cases had been on now for about three years, and as far as he could see they were still a long way from a decision. They were very anxious to get rid of this German litigation, because there was a long frontier between Germany and France, and it was difficult to keep the Germans from doing there what they did in a great many other places, from pushing over the frontier and selling their wares. Major Page was on his way back from Berlin to tell them the result of his interview with the parties there. From his (the Chairman's) intimate knowledge of the German character, he thought they would not come into the matter at once, but probably they would after a little time. He would make no predictions, for being a prophet he found to be a very unsatisfactory occupation, but he might say that if they succeeded in amalgamating abroad as they had done in England, it would be an excellent arrangement for the benefit of their property. Their position now was this. They were making a profit; their profits so far had enabled them to pay off their previous losses, and they started fair with a considerable amount of tangible property in hand, not owing anybody anything. They were partners in a rapidly increasing business in Britain, where the patents were established beyond the possibility of reversal almost. That justified the statement that the company was in a sound position, and one from which they would reasonably soon reap benefits. Coming to the capital account he said there was nothing new. The share capital on the debtor side, £375,000, was slightly diminished compared with the corresponding period of last year, when it was £377,983, and that was explained by an item of forfeited shares, £3,530 as against £365 last year. Sundry credit balances, £4,055 19s. 7d. It was very odd to him, not being an accountant, to call what you owed somebody else a credit balance. Special reserve against depreciation £3,000. It was much better to be secure against contingencies. That brought them to the debit balance on September 30th, 1886, £5,834 3s. 1d. On the other side of the account they would see the old story, cost of patent rights £105,251 4s. 8d. When people consented to pay such a large sum for patent rights they were simply mad, and Mr. Swan was happy enough to participate to his very great advantage and that of his friends in the benefits accruing from the madness of their fellow creatures. Mr. Edison was equally eminent, but he had not the solid pudding which Mr. Swan had got, and which, having got, they did not begrudge. But let them look at it. It seemed a very large sum of money to pay for a patent right, and the payment would have been very much more satisfactory if it had been admitted to be a patent; but they had had to fight for it, and prove that it was what it professed to be in the law courts. There was evidence of the madness of people who bought patents in a mania. Everybody thought he had a gold mine in the incandescent lamp. Now they had got the patent they would have possession of it for six years, and during those six years they had the opportunity, if they were as wise and prudent as the ordinary tradesman, and conducted their business on the lines of an ordinary trade, to improve their commodity and to expand their connection; so that when they emerged from the protection of the patents they would have an established connection and a trade mark which would enable them to compete with all comers. That was their policy and position, and after all he was not sure that that £105,000 was too great a price to pay for it. He wished to call attention to their outlay during the past year. They had spent in a variety of ways £3,330 in addition to that £105,000; but they had deducted from that 20 per cent. for depreciation to the debit of revenue. That was a very liberal scale of reduction; if there was an error, it was not too little but too much, but they had better be liberal than skip it. Shares in the Edison and Swan Company, £208,478, he had already explained. Sundry debtors, £10,160, of which about £9,000 was on good book debts from subtantial customers, and was a perfectly good asset. Stock in hand, £8,221; that he had explained in their business was essential. The lamps indicated by that price were put down at the cost price, and of course if they were sold it would be at a profit. They had invested in Prussian consols £13,116. They were obliged, being a foreign company in Germany, to invest at least £5,000 in those consols, and finding it a good investment they had put some of their eggs in that basket. Loan on mortgage, £14,300. They lent their partners that sum on the mortgage of the new and beautiful factory at Ponder's End, which was worth a good deal more than that; the mortgage had since been paid off. Investment in 3 per cent. Consols about £2,000. Cash on deposit and in hand, £16,669. Thus they would see they had a very large amount of money, or assets as good as money, in hand. He wanted to emphasise this, that but for the unfortunate fact that they had on their books the debts of their youth they would have been in a position to pay a fairly good dividend. As prudent people they could not go on without wiping out those debts once for all; they had applied their profits to that purpose, and were still enabled to carry forward a small balance for the benefit of the current year. Having explained everything as fully as he could, he would move that the report of the directors and the accounts for the year ending September 30th, 1887, be received and adopted.

Mr. F. R. Leyland seconded the motion.

Mr. Scott asked how long Mr. Swan's salary was going on, and what he did for it.

The Chairman said it was part of the agreement that Mr. Swan should receive a salary for seven years. Mr. Swan was part of the purchase price; they bought not only his patents for what they were worth at the moment, but his brains also for a term of years. He supposed it must be considered a prudent bargain. It would last two years longer. He gave them the benefit of an extraordinary inventive genius, was always at their call, and was an eminent scientist whose name was known far and wide, and those who knew his qualities respected him very much.

Mr. Verity spoke at some length in commendation of the course pursued by the directors, concluding his remarks by expressing the hope that Mr. Swan, who had made a great deal of money by the sale of his invention to the company, but who was legally entitled to the salary he now drew under contract, would relinquish part or the whole of that salary in consideration of the position of the company, remembering that the shareholders had as yet reaped no benefit.

Mr. Reynolds could not agree with the last speaker with regard to Mr. Swan's salary. The £400 a year he received from this company was a paltry sum to pay to one of Mr. Swan's abilities and repute, and he would be only too pleased to give him three times the amount if he would transfer his services to his (Mr. Reynolds's) firm. Mr. Swan's house, which was beautifully lighted, was practically open to everyone in the kingdom to inspect, and it must have done this company a great deal of good by inspiring a demand for lamps. The speaker regretted the use by the chairman of the term "rascality of infringers," and regretted that no allusion had been made to impending litigation with the Brush Company.

Mr. Killingworth Hedges asked whether the factories at Cologne and Lille were still working, and was answered in the affirmative. Proceeding, he said with regard to Swan lamps, he could assure Mr. Verity (who had alluded to the fact that preference is everywhere shown for the Swan lamp) that they were the most efficient. Nobody would work Edison lamps if they could get Swan's. The reason of the continued use of Edison's was that where the fittings had been put up for Edison lamps, only Edison lamps could be used. He anticipated an enormous demand for lamps within a very short period. He was himself connected with an undertaking which would call for 50,000, and was aware of other contemplated stations which would bring the total requirement up to two million lamps. As these lamps would only burn for a certain length of time, say a thousand hours, they would see that there was a good prospect of a large income, and they might expect a good dividend soon.

The Chairman thanked the shareholders who had given advice, and said they did not care to go into the contests of opinion between scientific men, particularly in a matter so subtle as the differences of opinion about different lamps. It was quite sufficient for them that their patent was protected, at an immense cost and after long litigation, in which the highest legal and scientific talent was engaged. They were willing and indeed determined to rest upon the decisions they had obtained. He might observe incidentally that, taking Britain merely as an illustration, it was quite competent for the public to call upon them to supply either the Swan or the Edison lamp. They could get lamps from Mr. Edison, upon terms rather less advantageous to them, as a matter of profit and loss, than to the manufacture of their own lamps, it was true. It was a pretty good test of the relative value of the two things that the demand for the Edison lamp had absolutely died out, and now the whole demand was for Swan lamps. That was an important factor in their negotiations abroad, for the men who were fighting there had for one of their chief reasons for desiring combination their knowledge of the superiority, as a practical commercial thing, of the Swan lamp, and they were in consequence prepared to make certain concessions, which were not, however, such as they could listen to. With regard to the litigation with the Brush Company, he had had interviews with Lord Thurlow and Mr. Sellon, but could not learn that they had anything further to advance in opposition to the claim of the Edison-Swan Company than had already been brought out in the Woodhouse and Rawson suit. That being the case, it could scarcely be expected that they would yield their claims. He had intended when speaking of rascality to allude to those persons who had no patents of their own and deliberately infringed, and not to those honourable antagonists who thought they had a patent but had not. The litigation was going on, and Mr. Crisp, their excellent solicitor, to whom they were under deep obligation for the energy, skill, and knowledge with which he had conducted their case, would be able to inform them what the present position actually was.

Mr. Crisp said he could not comply to the letter with the chairman's request, for there were many points in connection with litigation which were secrets, and could not be disclosed. But he could tell them the general position. They were proceeding practically against the Brush Company upon precisely the same lines as those upon which they proceeded against Messrs. Woodhouse and Rawson. Exactly the same issues were raised as were decided in their favour by Mr. Justice Butt, and by the Court of Appeal unanimously upon one point and by a majority of the Court on others. There was nothing new brought forward by the Brush Company, no objection, no notice of anticipation, which had not been thoroughly threshed out. In a second action the Brush Company had sued them upon the Lane-Fox lamp. They had had a great deal of anxiety about that lamp, and he might say quite seriously, without any desire to be jocular, that their anxiety had been to discover what possible ground there was for the bringing of the action. Nobody on their side, either legal, scientific, or practical, had yet been able to discover a weak point in their defence with regard to this lamp.

The motion was then put, and carried unanimously.

Mr. F. R. Leyland and Mr. W. C. Quilter, M.P., the retiring directors, and the auditors, Messrs. Quilter, Welton, and Co., were re-elected for the ensuing year.

Mr. Swan desired to be allowed to answer questions that had been put with regard to himself. The shareholder who had made some comments upon his connection with the company spoke under the impression that he had practically disconnected himself altogether from the progress of electric lighting invention. That was an entire mistake. He was always working in one way or another at matters which, he thought, would be beneficial to the company; and, so far as the lamp was concerned, the company had quite recently taken out a patent which would, he believed, prove valuable in connection with the improvement of the incandescent lamp. There was one thing which ought to be remembered by those who grudged the small payment made to him, and that was that when the company was first formed he did not offer his services, but they were sought. It would have been very much more in accordance with his wishes if he had been left entirely free, and not been solicited to occupy the position which he now did occupy. If he had been, he was quite sure it would have been very considerably to his pecuniary advantage, for the consequence of his taking the position was his leaving a very lucrative business at Newcastle and coming to London, so he had made sacrifices in connection with that payment, and had not been at all profited by it.

A vote of thanks to the chairman and directors brought the meeting to a close.

Telegraph Construction and Maintenance Company, Limited.

The twenty-fourth ordinary meeting of this company was held at the company's offices, 38, Old Broad Street, E.C., on Tuesday, February 28th. Sir Daniel Gooch, Bart. (Chairman), presided. At the request of the Chairman the notice convening the meeting was read. The manager, Mr. William Shuter, read the minutes of the last meeting, which were confirmed.

The report of the directors stated that the accounts for the year show a net profit of £88,798 6s. 7d., after charging the interest on the debentures. To this sum must be added £51,278 4s. 3d. brought forward from last year, making a total of £140,076 10s. 10d. From this amount is deducted the interim dividend of 5 per cent. paid July 19th, 1887, amounting to £22,410, leaving £117,666 10s. 10d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £50,436 10s. 10d. to be carried forward to the next account.

During the past year a considerable amount of work has been carried out by the company in the manufacture, laying, and repair of cables in various parts of the world. The gutta-percha department has manufactured a length of over 8,000 miles of insulated telegraph wire, and the cable factories have been actively employed during the greater part of the year. The company's steamships have made voyages to the Red Sea (Perim, Assab, Massowah, &c.), to the Mediterranean (Gibraltar, Malta, Zante, &c.), and to the Atlantic (Lisbon, Halifax, Valentia, &c.) Cable repairs have also been executed in the North Sea and English Channel. The company's ss. *Kangaroo* has been chartered to the Italian Government for distilling purposes in the Red Sea. The company's steamships and the factories at East Greenwich and Wharf Road are in efficient working order.

The Chairman moved the first resolution, which was:—"That the report and accounts of the directors to the 31st December, 1887, submitted to this meeting be, and the same are hereby received and adopted, and that the dividend of £1 16s., in addition to 12s. per share interest or interim dividend paid to June 30th, 1887, be paid upon all shares of the company for the year ending December 31st, 1887. And that such dividend be paid free of income tax." He said:—The work you have done represents the profit of the work. We have laid a considerable length of cable, and have also been at the expense of some repairs for the Brazilian Company, Mexican Company, Anglo Company, and German Company. You will see that we have made about 8,000 miles of cable. We have been doing much better this year than we have ever done. I hope that we may depend upon this increase continuing. The difficulty is for me to make a speech because I have nothing to say. I cannot go into the details, but if there is anything in these accounts which you wish to be explained, I shall be glad to explain them. I will move the resolution which I have read to you.

Mr. McKay said that the shareholders had reason to congratulate the board on the net increase of the earnings of the year, amounting to £13,147, as compared with the previous year. Looking at that large increase, it was surprising that they did not condescend to offer a little increase of dividend. They had gained sufficient to pay nearly three per cent. in addition to the dividend that they usually paid. The fact was that the dividend ought to be contingent on the earnings of the company. That was the natural view to take of the question. The dividend should be contingent on the earnings. They had had a good year, but they did not give the shareholders one penny-piece more than they gave them the year before. If they could show any reason for this they must listen to it. But it was only reasonable to look for an increased dividend. However much the work increased, there was one thing, the dividend did not increase. It was fixed, and as immovable as the Pyramids. It went on, year after year; it mattered not how much work they did, there was the wretched £1 16s. He would take another point. They had made 8,000 miles of cable; that was an increase of 4,690 miles. Now in 1885 they made 2,833 miles; still there was the £1 16s. dividend In 1886 they made 3,308 miles; still the £1 16s. And in the last year they had actually more than doubled it, and yet there was that miserable £1 16s. Now there was another query in that document. The property had evidently depreciated since the previous year £223,345 8s. 10d. That was under the heading of freehold, leasehold premises, machinery, &c. How was that to be explained? It gave him rather an electric shock; how it could be depreciated to that extent surprised him. Those were the two points he brought before them. There were many other things that might be queried, but that was what he fixed upon. There was another point. During the past year the board had got rid of the Telegraph Construction Bonus Trust. That was done with, and what he wished to ask was, what was the amount standing to the credit of the trustees of that fund at the bankers, and unpaid to-day or yesterday? He supposed that was a fair question to put. If it was not he would not urge it. He would like to know what that amount was. Now there was just one other thing; he made a passing reference to the shape of the balance-sheet. He did not suppose that the chairman or anyone of the directors would have the courage to get up and say that it was in accordance with the Act of Parliament. He thought it would be a great satisfaction to the shareholders if they were to conform to the Act of Parliament in drawing up those balance sheets. Whatever might be recommended by chartered accountants and auditors, they ought not to allow an Act of Parliament to be overridden by their accounts. If he was not speaking to the point, and of facts, they might contradict him. He said, however, that that document was not right; it was not according to Act of Parliament.

Mr. Gibson (a shareholder) said that he felt very much obliged to Mr. McKay for trying to get a dividend, but at the same time he felt that the dividend, although contingent upon the profits, they were very glad to see carried on from year to year. He considered that this wretched £1 16s. was not to be despised when they took into account what they had had to contend with in the shape of trade, &c. He would not be sorry if they could believe that this dividend was as immovable as the Pyramids. He thought that they had great cause to be thankful that the business had been carried on in such a satisfactory manner as it had been for many years. He would not like to disturb it.

A Shareholder asked if the bonds that expired last year were to be renewed, but the Chairman ruled that they could not answer that question.

The Chairman considered that if they read the heading of the item to which Mr. McKay referred, they would find that it included stores, stock, &c., and at the end of last year its value happened to be very low, while at the end of 1886 it was very high. It was the question of stores, cable, and other things in common. That was the explanation of that figure. The question of cable trust that company had really nothing to do with. It was put in the hands of trustees, and he believed they had a small balance in hand.

Mr. P. Rawson said there was a small balance in hand because persons would not take the trouble to apply for the balance due to them. The money had all been distributed, so that each party had the power to collect what was due to him. The amount remaining was quite trifling. If they enquired at the office they could obtain the amount exactly.

The Chairman said that he believed that the accounts were not subject to any Act of Parliament; the form had been the same for 24 years. He believed they were perfectly in legal form. In this, they could not deal with their accounts as in a railway company. They were obliged, therefore, to make these accounts a little different from what a railway company's accounts would be, but there was nothing illegal in them. He hoped that their dividend would go on all right, and that they would always get that £1 16s. dividend, making £2 8s. 0d. a year. It was a very satisfactory dividend, and he wished he got the same in other companies. Mr. McKay was wrong in supposing there was any great difference in the amount available. There was only about £1,000 difference between the profits of 1886 and 1887. The amount he (Mr. McKay) wished to get rid of was the amount brought in from the previous account. They carried over £50,000 and in the previous year £51,000.

Mr. McKay said that the chairman did not discuss the difference in the earning between 1886 and 1887 which was £13,147.

The Chairman said that it was the amount brought in from the previous year of which he spoke. He was misleading himself. The amount in 1886 was £51,000, and this year it was within £1,000 of what it was in the previous year.

Mr. McKay, having withdrawn his other objections, said that he wished to make one observation in reference to the form of the account. Although they stated that there was a precedent of 24 years, he said it was not in accordance with Act of Parliament.

The Solicitor, at the chairman's request, here stated that there was no Act of Parliament prescribing any particular form for their accounts.

Mr. McKay asked whether the Limited Liability Act did not decide the form, but the chairman decided that they would take the risk.

A Shareholder asked if there was any objection to putting in the particulars as to the leasehold and freehold property in detail.

The Chairman did not think it would be satisfactory in the end.

The Shareholder said that if it would be unsatisfactory, then his objection was of no avail.

The Chairman said they thought it against their interest to put in these details.

The resolution was then put to the vote and carried unanimously.

The Chairman proposed: "That Sir George Elliot, Bart., and Mr. Philip Rawson, be and are hereby re-elected directors of the company."

General Turner seconded this resolution, which was carried unanimously.

A third resolution was also carried unanimously: "Resolved that Mr. John Gane, F.C.A., and Mr. James Glegg, F.C.A., be and are hereby re-elected auditors of the company for the year 1888, at the same remuneration as last year."

A Shareholder moved a vote of thanks to the Chairman, which was seconded by another shareholder and carried unanimously. The chairman responded.

Mr. Shuter stated that: "The second Bonus Trust having been closed in June last, the holders of these certificates are requested to send them in, with all outstanding coupons attached, to the company's bankers, Messrs. Barclay, Bevan & Co., who have about £4,000 of the funds still unclaimed."

The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

THE half-yearly ordinary general meeting of this company was held last Tuesday at the City Terminus Hotel, Cannon Street, Mr. Wm. J. Silver presiding.

Mr. W. J. Tyler, the Secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, said: It is unnecessary for me to remark that the present state of things is very different in results from what it has been for many years past. We have endeavoured to explain the causes in the few remarks that we have made in the report. This check to our prosperity we hope is only temporary. I must, however, remind you of the general depression that has prevailed in all branches of trade for several years, during which time we have been able to distribute an average dividend of 15 per cent. You may depend upon it that no effort will be spared to improve our position, and I am glad to say that the prospects of doing so are encouraging. Though we have increased our returns in general manufactures, thanks to the efforts of those around us and to additions to our agencies at home and abroad, where there is a demand for our products, we have had to meet competition by contenting ourselves with a smaller profit rather than sacrifice quality. The few orders for submarine cables have told doubly against the results of the year. Whilst, on the one hand, we have not made the profit that that department has in former years, and certain heavy fixed charges have been made which cannot be avoided, we have been put in an efficient state and ready to execute contracts, and these charges have been thrown upon the other branches of our business. I think it is not too much to expect that electric lighting will shortly come into general use. Now, this branch has occupied a vast amount of anxious attention in order that we may meet the demand, however extensive, and here I may say that the works are in all respects in the highest state of efficiency. Under these circumstances, we have had no hesitation in applying some of the profit of the balance of previous years to the purposes for which it was originally intended—namely, towards the equalising of the dividend—and, therefore, I beg to move "That the report and accounts be received and adopted, and that a dividend of 10s. a share, free of income tax, be paid on and after the 29th inst., making 10 per cent. for the year."

Mr. Neil Bannatyne seconded the motion.

General Trevor said that before the report was adopted perhaps he might be in order in referring to the form of the auditor's certificate. He believed it was usual in commercial undertakings that had reserve funds invested for the auditor to certify to the existence and to the value of those securities. He would read the form of certificate which a kindred company adopted. The auditors there said:—"We have also inspected the several securities held by the company and the inventories of the various stocks in hand, with stores, materials, &c." Their auditor did not give that form of certificate—in fact, did not certify that he had inspected the securities at all. Perhaps it would be more satisfactory if that system were adopted, and he would move, when the auditor came to be elected, that he be instructed to that effect. The debts owing to the company were nearly £90,000. He would like to ask whether the directors anticipated that any of those debts would be bad. He saw that the shares and debentures in other companies gave £9,000 of interest, which he regarded as a very fair rate, but he would beg to suggest that the nature of the companies in which more than half their reserve fund was invested should in future be made known in the balance sheet.

Mr. Lamont asked whether there was any chance of cable work turning up shortly.

Mr. Lee asked whether the 120 miles of cable referred to in the balance sheet realised anything in the way of rent.

The Chairman, in reply, stated that the auditor had carefully inspected all the securities, but as regarded the nature of those securities it was deemed advisable not to publish it. As to Mr. Lamont's question, he could only say that they all lived in hopes. They received a fair rent for the 120 miles of cable referred to by Mr. Lee. All their debts were very good.

The motion was then put to the meeting and agreed to *nem con.*

Mr. Gray proposed, and Mr. Henderson seconded, the re-election of the retiring directors (Mr. Silver and Mr. Bannatyne), which was unanimously approved.

The Chairman having briefly acknowledged this renewed mark of confidence,

Mr. Wallace proposed the reappointment of the company's auditor at a fee of 30 guineas.

General Trevor moved, as a rider to the motion, that the auditor be instructed to add to his certificate the following words:—"I have also inspected the several securities held by the company and the inventories of the various stocks in hand, with stores, materials, &c."

Mr. Corner seconded the motion as thus amended, and it was agreed to after a brief discussion.

Mr. Moy, in a few felicitous remarks, then proposed a vote of thanks to the chairman and directors for their able conduct of the company's affairs, which was seconded by Mr. Verity and carried unanimously.

The Chairman, in replying, said that the directors, in the work they did for the company, wanted merely a fair field and no favour, and the shareholders might be sure that their wishes would be carried out to the fullest extent.

The proceedings then terminated.

The Anglo-American Brush Electric Light Corporation, Limited.

THE directors, in submitting the report and statements of account for the year ended 31st December, 1887, state that during the past year there has been renewed activity in the electrical industry both at home and abroad, and although in the present state of electric lighting the business still calls for sacrifices out of proportion to the reward it offers, there are indications that it is entering upon a new phase, and the directors have reason to hope that the time is now not distant when the work done by the Corporation will be of a sufficiently profitable character to admit of the regular payment of dividends. The electric light is becoming more and more to be regarded as the light of the near future. Clubs, hotels, passenger steamers and war ships are not considered complete unless provided with the electric light, and in the case of theatres lighting by electricity is now recognised as one of the necessary precautions against danger from fire. Municipalities, also, whether they own gas works or not, are showing an increasing inclination to encourage the establishment of central stations for the supply of electricity.

The board have therefore continued to pursue the policy fully explained in the last report, of developing the business of the Corporation, and of anticipating as far as possible the demands which will arise in connection with the carrying out of both public and domestic lighting on a large and commercial scale. With this view patent rights have been secured in connection with the distribution of electric currents of a high electromotive force to be distributed over large areas, and transformed to a low tension for domestic purposes. Considerable progress has been made by the Corporation, in common with others, with this system of distribution, as well as with that by means of accumulators, and the board are now negotiating in several directions for contracts for the establishment of central stations for the supply of electricity. In matters of detail the Corporation have made appreciable advance during the year—in the further improvement of their machines and other apparatus, in the better organisation of the business, and in increasing the aggregate amount of their transactions. It is to be regretted, however, that owing to competition and consequent reduction of prices, profits have not increased in anything like the same ratio as the volume of business.

Among the satisfactory features of the year's work may be mentioned the lighting of the Royal Jubilee Exhibition at Manchester, by means of nearly 600 arc lamps, to the entire satisfaction of the authorities, and the success which attended this work has materially contributed to the Corporation receiving the contract for lighting the largest part of the forthcoming exhibition at Glasgow, by means of 500 arc lamps. The Corporation also took an important part in the lighting of the American Exhibition in London. They have also carried out a large number of installations in clubs, theatres, on board ship, &c., some of the more interesting being the Lyceum Theatre, Edinburgh, the installations on board the Peninsula and Oriental Company's steamships *Victoria* and *Britannia*, the Hall of the Worshipful Company of Drapers, and the Royal Albert Hall.

The long pending negotiations with the Commissioners of Sewers, for the lighting of a part of the City of London, have been pushed forward with energy, and although a definite decision has not yet been arrived at, the board trust that the matter will speedily be brought to a satisfactory conclusion.

It was stated in the last report that the Corporation had acquired the business of the International Electric Company in Austria-Hungary. During the year this business has been energetically developed, and there are good indications that it will constitute an important source of revenue to the Corporation. The firm of Kremenezky, Mayer and Company, in Vienna (under which title the Corporation are there trading), have carried out a variety of satisfactory contracts during the year, whilst at Temesvar, in Hungary, where upwards of thirty miles of streets are lighted by electricity, the Corporation have since taking over the installation materially increased the efficiency of the plant, and reduced the expenses of working so that the balance is now on the right side, and the Corporation, having undertaken to supply the light to private consumers, are taking steps to extend the capacity of the works.

In the previous report the directors referred to the litigation which was then pending in regard to the infringement by a few manufacturing firms of the patent held by the Corporation for compound-winding of dynamos. The directors are glad to be able to report that the suit has been amicably settled out of Court, Messrs. Crompton & Co. and their colleagues having accepted licenses from the Corporation upon the usual terms, and paid a sum of money in satisfaction of past royalties and legal costs incurred. In connection with this case it became necessary to take the evidence of Mr. C. F. Brush, in America, by commission, and Mr. Percy Sellon, the Corporation's electrician, who was entrusted with the mission, obtained evidence which, as was anticipated, confirmed the position of the Corporation in regard to this matter. Licenses to manufacture compound-wound machines, under the Corporation's patent, have now been accepted by all the leading dynamo manufacturers in this country, including Messrs. Siemens Bros., Messrs. Crompton and Company, the Edison-Swan Company, Messrs. Mather and Platt, Messrs. Elwell-Parker, Messrs. Greenwood and Batley, the India-Rubber and Gutta-Percha Company, Messrs. Goolden and Company, Messrs. Paterson and Cooper, and many others. One firm of manufacturers in Scotland have as yet declined to accept the very moderate terms demanded by the board, and for the protection of the licensees of the Corporation the board have lately instituted proceedings with a view to prevent the infringement of their rights.

The cross actions with the Edison-Swan United Electric Company, in which the Corporation were involved at the time of the last report are still pending, but are expected to be heard shortly. This litigation, while exceedingly to be regretted, from its serious character to your interests, is, however, of far graver importance to the Edison-Swan Company, involving as it does the validity of the most important of their incandescent lamp patents, which, as would appear from the balance sheet, stand at about £300,000, and upon which they rest their claims for an absolute monopoly of lamp making. The board take this opportunity of placing on record their regret that their efforts to bring about an amicable settlement, consistent with your interests, have failed, and that everything points at present to the necessity of the case being submitted to the final decisions of the Courts of Law. The board have, however, given their careful consideration to the matter, and have spared no trouble or expense to ensure success in the Law Courts, and the great strength of the evidence they have been able to collect, combined with the high legal and scientific advice by which they are guided, enable them to state their full confidence in the result.

The Bill introduced last session by Lord Thurlow to amend the Electric Lighting Act of 1882, based as it was in a large measure upon the evidence taken by the Select Committee of the House of Lords in 1886, was very favourably received, and passed by that House, the Prime Minister expressing the opinion that the enterprise should be allowed full scope, that all obstacles which had hitherto impeded it should be removed, and that terms should be offered which experience had shown capitalists would accept. The prospects of carrying the Bill through Parliament were therefore very good, had it proved possible to proceed with it in the House of Commons last session. The Bill has been, however, re-introduced by the chairman, and there appears a reasonable prospect that it will become law this session.

The capital account shows an increase of £34,939. This is due to carrying into effect the agreement with the International Company, already referred to, which involved the issue of 1,476 fully paid shares, and to the issue of 1,354 new shares, under the resolution passed at the last meeting, giving the directors power to issue new capital for the purpose of developing the business. Owing, however, to the fact that this new issue was not largely responded to at the time, the directors thought it expedient to make a call of £1 per share upon those shares upon which the sum of £3 only had been paid.

The increase in the patents, development, and goodwill account of £3,580, is due mainly to the reacquisition from the Eastern Electric Light and Power Company in liquidation, of the Brush and Lane-Fox patents for the whole of the Indian Empire, exclusive of those for the Presidency of Bombay and the Nizam's dominions, which had already been disposed of by the liquidators. The increment includes also the unrealised balance of the assets realisation accounts, which appeared in previous balance sheets in connection with the absorption of the Great Western and Brush Midland Electric Light Companies, and which has been so dealt with in accordance with the principle laid down at the time of taking over these companies, and the payments during the year for up-keep of patents.

It will be seen from the balance sheet that there is a marked increase in the amount owing to the Corporation, which evidences the larger volume of business.

It will be perceived that despite the larger operations conducted during the year, the general charges show a reduction of about 5 per cent. Several of the economies effected by the directors now appear in the accounts for the first time; amongst these may be mentioned a reduction in comparison with the previous year of nearly £500, in carriage and freight, owing to an alteration in the classification of electric apparatus, which was conceded by the Railway Companies in the early part of the year, as the result of representations made by the Corporation. The directors have also been successful in effecting several other and larger economies, which, however, are not yet reflected in the accounts. Among these may be more particularly mentioned the surrender of the lease of the premises at Portpool Lane, and of the recent subletting of the Borough Road Works.

The item of gross profit, which shows a substantial increase upon last year's figure, includes the amount of £3,132, being the estimated value of the fully paid shares in the International Company held by the Corporation, and which were relinquished as part consideration for the Austro-Hungarian business. The gross profit strictly due to the current business shows an increase of about 12½ per cent. The directors propose that of the balance of profit £2,500 be added to provision account, and that £2,562 12s. 1d. be carried forward to next account.

The directors, following the precedent of numerous other industral undertakings, have after mature consideration decided to adopt the principle of remunerating the chief officers in proportion to the net profits distributed by the corporation. The arrangement is that an amount equal to 10 per cent. of the dividend declared shall be set aside as a fund to be divided, in proportion to salary, amongst the officers from time to time nominated by the board under specified conditions. The board are satisfied that the adoption of this plan will, in view of the appreciation expressed by the staff, have results highly beneficial to the proprietary, and the board therefore cordially recommend it for adoption by the shareholders.

Owing to pressure of other engagements, Lord Sudeley found it necessary last spring to vacate his seat at the board, and in July last Major-General Webber exchanged the position of managing director for that of consulting technical adviser, an office which in view of the immediate prospect of street and private lighting contracts is one of daily increasing importance to the corporation.

Profit and Loss Account for the year ended 31*st December*, 1887. DR.—To general charges, &c.: Rent, £1,687 12s.; rates and taxes, £601 12s. 1d.; water and lighting charges, £439 18s. 8d.; fuel, £627 9s. 4d., £3,356 12s. 1d.; directors' fees, £1,500; auditors' fees, £52 10s.; salaries, £4,782 2s. 8d.; law charges, £300; insurance, £555 11s. 4d.; postages, stationery and printing, £903 4s. 11d.; travelling, carriage and freight, £340 8s. 9d.; advertising, agency charges and sundries, £1,390 11s. 8d., £9,824 9s. 4d.—total general charges, £13,181 1s. 5d.; provision for maintenance and depreciation of plant, £2,250; provision for bad and doubtful debts, &c., £500, £2,750; amount carried to balance sheet, £5,062 12s. 1d.; total, £20,993 13s. 6d. CR.—By balance from last year, £1,532 0s. 9d.; gross profit, £19,461 12s. 9d. (this does not include the year's profit of the Austro-Hungarian businesses, the accounts of which have not come to hand); total, £20,993 13s. 6d.

Gulcher (New) Electric Light and Power Company, Limited—This company is formed for the purchase of the goodwill, patents, plants, materials, stock-in-trade, contracts, and other property of the Gülcher Electric Light and Power Company, Limited. Owing mainly to losses sustained in the years 1882 and 1883 the Gülcher Company, so the prospectus states, was unable to continue trading advantageously without some kind of reconstruction. Accordingly, with a view to reconstruction, the company went into voluntary liquidation, and shortly afterwards a committee of investigation was appointed to report upon its condition and prospects, and to advise as to the course which should be pursued. The capital is £70,000, in 70,000 shares of £1 each, of which 50,000 are 10 per cent. preference shares and 20,000 are deferred shares. The business is acquired in consideration of a payment of £16,000 and 20,000 deferred shares to the liquidator of the old company. The present issue is of 25,000 preference shares.

Brighton Electric Light Company, Limited.—A meeting of the shareholders of the Brighton Electric Light Company was held at the works of the company on the 18th ult., and great satisfaction was expressed at the nature of the report for the past fifteen months. The managing director, Mr. Arthur Wright, was congratulated upon the successful manner in which he has conducted the company's business. There had, it was stated, been a great increase in the consumption of electricity, and the plant had recently been considerably added to in order to still further cope with the business coming before the company. It was resolved that an expenditure of £3,000 should be made on additional plant.

West African Telegraph Company, Limited.—The half-year's interest due March 1st upon the 5 per cent. debentures will be paid at the National Bank of Scotland, Nicholas Lane.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—The directors have decided to declare a half-yearly interim dividend, at the rate of 7 per cent. per annum.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 24th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,750.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for week ending February 24th, amounted to £4,643.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

(Continued from page 206.)

It has been held by the authors of these papers that it is impossible to use transformers in series if we wish to maintain a constant potential difference at the terminals of the secondary when the resistance of the secondary is altered: that is to say, it is impossible to maintain constant potential between the lamp terminals if the number of lamps in the secondary circuit is varied. Well, no doubt if you have nothing more than the mere primary and secondary, and if you keep a constant current through the primary circuit, which is all you can do if the transformers are in series, it is no doubt impossible to produce a constant potential difference between the terminals of the secondary when the resistance of the secondary is altered. But there is a means of producing a constant potential difference between the terminals of the secondary, which, it appears to me, would lead to good results. I do not know whether it has been tried. The method is one analagous with the compounding of a dynamo. In a dynamo, compound-wound, we use, of course, a shunt coil, but we have also a series coil which increases the magnetisation of the field magnet when the current produced by the dynamo is increased. Now we can get exactly the same thing with transformers. Supposing this is the secondary which is joined in the ordinary way to the lamps. Now let there be an auxiliary induction coil having its primary in the main secondary circuit and its secondary joined up that it adds a potential difference to the secondary circuit and adds a greater potential difference, the greater the current passing through the main secondary. Now, that is exactly the arrangement of the compound-wound dynamo. The main primary and secondary would correspond—so to say—with the shunt coil of the compound-wound dynamo and the primary and secondary of the auxiliary induction coil to the series coil, that is to say, a constant current passing through this coil would, roughly speaking, produce a constant electromotive force here, which, of course, would not produce a constant potential difference between the terminals. Without this device, if your resistance in the secondary is altered, just as in the dynamo, you cannot get a constant potential difference merely by running at a constant speed; but if you have here another transformer, then the greater the current which is produced in the secondary current feeding these lamps the greater will be the induction here, and the greater the potential difference added to this circuit. And so I believe it would be possible by such an arrangement to get a constant potential difference between the mains of any house for a constant current employed in the primary coils all in series. It is not necessary, of course, that these two transformers should be quite independent; all that is necessary is to put a tertiary coil on the transformer, so that on one transformer you have a primary, a secondary and a tertiary coil. Some three or four years ago my colleague and I endeavoured to work the thing out mathematically, to find a means of getting a constant potential difference between the mains. But when you come to deal with the primary, secondary and tertiary wire, the mathematics become extremely complicated, and we thought that we should do better by resorting to experiment. Apparatus was made, and it was for these experiments the little meter for measuring alternating volts we had the honour of bringing to your notice last year was devised. It was necessary to measure a few alternating volts accurately, and therefore we had a voltmeter that measured four or five alternating volts accurately. Just when the experiments were about to start, I came across an account, published, if I remember correctly, by Messrs. Gaulard and Gibbs, in the *Engineer*, putting forward exactly the same device. Imagining that, as they were engaged on the Grosvenor Gallery installation, they had more opportunity of making experiments than we had, we did not pursue the matter further. Whether they arrived at any definite conclusion I do not know: I have heard nothing more about it since. I should be glad to hear from Mr. Mackenzie whether this system was seriously tried. I can imagine that it did not give proper results when first tried, just as the first compound-wound dynamo was not perfect; but it would be interesting to know whether it was ultimately successful. Had we not come across that account, published by Messrs. Gaulard and Gibbs, at the same time that we were starting on our own experimental investigation, we certainly should have pursued the matter and endeavoured to arrive at success. Just as the strength of the field produced by the shunt coil is increased by the series coil in a compound-wound dynamo, so the potential difference set up between the lamp mains in the house by the main secondary coil is increased by the potential difference set up by the tertiary coil. It is the more increased the greater the current in the outside circuit, that is the greater the current passing through the lamps. I am very glad to see that the idea of magnetic "lag," which means retardation of iron to be magnetised, quite apart from the production of Foucault currents in the iron, is gradually gaining acceptance, especially in consequence of the admirable work that has been done on this subject by Professor Ewing. The idea of magnetic lag, as apart from Foucault currents, was put forward some years ago in this room in our paper on electric motors and their government, and that the conception was used in all our calculations was simply laughed at by some writers and our names in some quarters were held up to reproach from our having brought out the idea of magnetic lag, as something different from the lag due to Foucault currents. There is a distinct delay in iron to accept magnetism, or to lose it, quite apart from Foucault currents, and which cannot be entirely avoided by any amount of lamination. I have spoken about the wrong ways of making measurements on the efficiency and power given by transformers. Let me say a word about right ways of making such measurements, and I am interested in doing this because, through the kindness of Mr. Kapp, who lent us one of his transformers some time ago, experiments have been made by third-year students of Electrical Engineering at the Central Institution, who have displayed, in connection with the subject, laudable perseverance. There is only, so far as I know, one method of measuring the power given to a circuit which contains self or mutual induction. The method is one employing the quadrant electrometer, and is that which was adopted by Dr. Hopkinson in measuring the efficiency of Messrs. Gaulard and Gibbs's transformers on the Underground Railway some few years ago. Suppose this is an ordinary quadrant electrometer and you wish to measure the power given to a circuit by alternating currents opposed by self or mutual induction, or both, then you can measure the power in this way: Put in series with this wire a wire having no self or mutual induction. I indicate this by a firm line in one case and a wavy line in the other. Let this firm line indicate a coil having a known resistance, but without self-induction. The quadrants are connected to the ends of this circuit and the needle connected to the other end of the circuit, the power given to which it is desired to measure. That gives you one measurement. Next, the needle is connected to the near end of that circuit, the quadrants remaining as before. It gives you a second measurement. Now, it can be shown that the difference of these two measurements expresses the power given to this circuit. Here is the alternate current dynamo sending a current through this—it may be the whole installation. In series with this put a wire of known resistance, not containing self or mutual induction, *i.e.*, an ordinary resistance coil. Then connect your needle with three points of potential, P, Q and S. The quadrants are joined, if you like, to these two, P and Q, and the needle to S, or the quadrants to these two, Q and S, and the needle to P. You get a steady deflection of the needle. Having done this you disconnect the needle which was connected with, say S, and you connect it with, say Q, and you get another steady deflection, and the difference of these two steady deflections measures, in terms of the constant of the electrometer, the power given to this circuit. The watts—the true watts—(independently of any amount of self or mutual induction, or lag in consequence of self or mutual induction) are found thus theoretically and absolutely correct. It is rather interesting, because the method occurred simultaneously to Dr. Fitzgerald, of Dublin, and myself at the Paris Electrical Congress. We were listening to M. Joubert's Paper on the measurement of alternating volts with an electrometer, of course, a very much simpler thing, and when he was reading this Paper it occurred to both of us to see whether it was not possible to do something more with the electrometer—that is, not measuring alternating volts, but, measuring the power. The Cardew voltmeter will measure the former. Of course you can measure alternating volts in this way—by joining one of the quadrants to the needle, and then joining the two pairs of quadrants to the two points, the difference of potentials between which you wish to measure, and it is well known that the deflection of the needle is proportional to the square of the difference of potential. It was during Mr. Joubert's reading of the Paper that this device occurred to Dr. Fitzgerald and myself, and after the meeting he came to me and said—"I have a method of measuring the power." I told him that I, too, had a method of doing the same thing, and I said, "If you tell me yours I will tell you mine." Well, the method is theoretically perfect; but it has distinct practical objections. The first objection is that it requires a non-inductive resistance to be put in series with that part of the circuit, the power given to which it is desired to measure. Of course there is a certain amount of power wasted in this wire. But that does not interfere with the accuracy of the experiment. Though it wastes a certain amount of power it does not destroy the accuracy of our measurement, but if a dynamo were already worked up to its full power giving current to a circuit, it would be inconvenient to have to introduce extra resistance into the circuit for the purpose of enabling the power to be measured. There is another and more serious objection which I was not aware of until within the last couple of years, that is: our formula is worked out on the assumption that the ordinary law of the electrometer as given, for example, by Clerk Maxwell, is true. The law of the electrometer is supposed to be that the deflection of the needle is proportional to the potential difference between the quadrants into an expression consisting of the potential of the needle minus half the sum of the potentials of the quadrants, all potentials being measured relatively to the outside case of the electrometer. Now, unfortunately the experiments made at the Central Institution showed that so far from this being the formula of the electrometer it is the exception for the electrometer to have this formula. I will not go into that at the present time; it will form the subject of a subsequent communication. I merely mention it to warn you, if any of you use the electrometer, that our method is worked on the assumption of the accuracy of the formula given in the books, and that it fails to give good results is not a proof that the method is wrong. (Laughter.) I warn you, therefore, it you want to have a very perfect method to be quite sure that you have a very perfect electrometer—at any rate an electrometer arranged so that this formula is true. We have found out that, as a rule, this formula is not true, and that a method thus carried out, pretty as it is, and perfect as it is, is inapplicable. Third-year students have made any number of experiments with this method, and the results generally were very unsatisfactory. There is only one method I know of by which you can measure the power and efficiency of a transformer. It is not an electrical method at all. It is this, we want to measure the power, of course, given to the transformer and the power given out by the transformer. How shall we do it? The power given out by the transformer can be easily measured if you only take care that the secondary circuit is giving a current to incandescent lamps. Suppose that is a secondary circuit. Let it give power to a *non*-inductive resistance like incandescent lamps. Then the power given out by that circuit would be quite accurately measured, since there is no lag, by simply taking the square root of the mean square of the volts into the square root of the mean square of the current. That is a Cardew voltmeter put as a shunt between the lamp mains, multiplied by a reading from a dynamometer, gives you the power given out by that circuit. You cannot get the power given to the primary by that method. You cannot put a Cardew voltmeter there. You can have it if you like, and you can put the dynamometer there if you like. But you will not get the power given to the transformer in consequence of the self-induction of the primary and the mutual induction of the primary and secondary. Well, how can you get the power? Put the transformer in a calorimeter. First put it in a watertight box, then in another box. Arrange a definite resistance in the secondary circuit and send a definite current through the transformer for a certain time and allow water to enter, say the bottom of the calorimeter, and to flow out at the top, and measure the temperature of the entering water and that of the water which leaves and keeps the current flowing until everything has become quite steady, until the temperature of the water as it flows out of the calorimeter ceases to rise, which we find in some cases takes as long as three hours to occur. Then, quite apart altogether from the specific heat of the transformer and calorimeter and so on, we have at once the power wasted in the transformer. Suppose, for example, that W is the number of grammes of water that flow out in *t* seconds, and supposing T is the difference of temperature between the entering water and the leaving water, which I suppose to have become quite steady, then the power, in watts, wasted in the calorimeter, given out in the form of heat, is equal to W, the number of grammes or cubic centimètres of water multiplied by the difference of temperature, T, divided by the time, *t*, in seconds, into a constant, ·239. That gives you the power wasted in the transformer. That, added of course to the power given out by the secondary, which is obtained from the next measurement, gives you the power put into the primary, and you have then the whole measurement with a considerable amount of accuracy. The power given out by the secondary is accurately measured by the square root of the mean square—that is to say, by the reading of a Cardew voltmeter, into the reading of the Siemens dynamometer. The power wasted is measured by the formula for the calorimeter just given, quite independently of the specific heat of the calorimeters, or of anything else. Then this added to the power given out by the secondary, gives the power put into the transformer. And the ratio of the power given out to the sum of the power given out plus that wasted in the calorimeter gives the *true* efficiency. Well, that method has led to very fair results. We have also put a voltmeter and a dynamometer in the primary circuit. Now you see the sort of results that students have obtained from a large number of experiments. Of course, I can only give you a few of the figures. We had something else; we not only had the apparatus just referred to, but for the interest of the thing we had an ordinary wattmeter in the primary circuit. In addition to the dynamometer then there was the thick coil of a wattmeter in the primary circuit, the fine coil wattmeter being a shunt to the primary circuit. Now you see the sort of results that are obtained with the different systems of measurement, which are particularly interesting, as we know what are the results which are true. The experiment was carried on in each case for some hours, the dynamo being kept running at a constant speed, so that everything was kept perfectly constant. In the first case, the circuit itself was broken altogether—*i.e.*, there was no current in the secondary circuit. This particular transformer was an exact facsimile of a transformer which Mr. Kapp had on the table last time, and I may mention that Mr. Kapp's method of indicating the power of transformers is an extremely satisfactory one. Very often when new apparatus is devised the nominal power is stated (for reasons pretty obvious) in excess of what the real power is. Transformers are on a par with the steam engine, at least Mr. Kapp's small transformers are, that is the actual power developed is much greater than the nominal. I do not know whether his dynamos are equally good. If so, they are extremely good. This is a nominal 2-H.P. transformer which does not, I am happy to say, give you only one horse-power. In the first case the volts of the primary circuit were 184·3. The volts of the secondary (circuit being open here) were 94·5. Then the actual power put in as measured by—let us take them in order—the wattmeter, the constant, of course, being carefully determined, not merely being the constant as marked on the instrument, which might be supposed to be correct for direct currents, but for alternating currents was 98·5 watts. The watts put in, measured by the product of the dynamometer and voltmeter, were 147; that is the watts measured by these when applied to the primary and not to the secondary circuit. But the actual power put into the whole circuit was only 53 watts, therefore both of these are enormously too large. Why? Because when the secondary circuit was broken the effect of self-induction of the primary, of course, was very much larger than when the secondary circuit was closed, and the errors, both of this instrument

KAPP AND SNELL TRANSFORMER.

Experiments made at the Central Institution by Messrs. Dykes, Lamb, Priest, Smith, and Zingler.

Primary.		Secondary.		Calorimeter.	Watts given out by secondary.	Watts given to primary.			Efficiency.		
a Volts	*b* Ampères	*d* Volts	*f* Ampères	*g* Watts wasted in heat	$h = \sqrt{d^2 \times f^2}$	$g + h$ True	$\sqrt{a^2 \times b^2}$	*j* From wattmeter	$\frac{100\,h}{g + h}$ True	$\frac{100\,h}{\sqrt{a^2 \times b^2}}$	$\frac{100\,h}{j}$
184·3	0·8	94·5	0	53·18	0	53·18	147	98·5	0	0	0
184·6	2·3	96·8	3·3	79·05	318·7	397·8	424·5	446·7	80·1	75·1	71·4
187·6	3·32	97·7	5·09	82·63	495·6	577·9	623	653	85·8	79·5	75·9
186·1	8·31	94·3	14·87	55·6	1416	1472	1546	1727	96·2	91·5	82
185·6	16·14	91·44	30·59	149·9	2813	2963	2995	3277	95·0	93·9	85·9

Each test given in the above table is the mean of five or six consistent results.

Efficiency $\frac{100\,h}{\sqrt{a^2 \times b^2}}$ neglects the lag due to the self and mutual induction of the transformer.

Efficiency $\frac{100\,h}{j}$ „ „ „ „ „ , also the lag in the fine wire coil of the wattmeter due to its self-induction.

Time of an alternation on all the experiments was about the $\frac{1}{480}$th of a second.

and these two, became immensely magnified—altogether too great—the readings are altogether wrong. The wattmeter says 98·5 watts put in. The product of the voltmeter and dynamometer says 147 watts put in. But the real watts as given by the calorimeter (and, of course, in this case, as the secondary is open, all the power is wasted in heat), was 53·2. The electrical methods, therefore, gave two to three times too much. Of course, as the secondary circuit is closed and less and less resistance is put in the readings given by a wattmeter and by these two become more nearly the same and more nearly equal to the truth, the truth being this added to this. Afterwards, as less and less resistance is put in this circuit with these numbers approach one another. But even for the maximum power they cannot become equal. For example, when 2,963 watts were really being given to the transformer, which is about four horse-power, the voltmeter and dynamometer made it 2,995 and the wattmeter 3,277 watts. It was worked in the next case with about two-horse power, or more accurately 1,472 watts were given, but the voltmeter and dynamometer made it 1,546 and the wattmeter 1,727 watts. Of course the sum of these two is the real power put in, so that the ratio of that to that is the efficiency. It comes to as much as 96 per cent. The differences in the watts measured do not arise from instrumental errors, but from errors in the method arising from neglect of self and mutual induction. It is interesting to observe that these readings, which are the square roots of the mean square of the volts into the square root of the mean square of the ampères are higher, as you might expect, than the true watts put in, and as I have said, they ignore lag altogether. It gives you the maximum put in if there were no lag at all. These you would expect to be higher than the true watts. You might not at first sight have seen whether wattmeter readings should or should not have been higher than the true watts. We see they are, and not only are they higher than the true watts put in, but even higher, as a rule, than the watts measured in the former way. That led me to investigate the question as to whether a wattmeter ought to give you an answer nearer the truth than the square root of the product of v^2 and c^2, or to give an answer farther away from the truth, and the result I have obtained approximately at any rate to this. Take a wattmeter—one like a Siemens wattmeter, which has practically no mutual induction but has self-induction. If a wattmeter be employed to measure power in a circuit having self-induction, this seems to be what is obtained.

$$\frac{\text{Watts given by wattmeter}}{\text{True watts}} = \frac{R}{R^1} \cdot \frac{\tau^2 R R^1 + L L^1 \pi^2}{\tau^2 R^2 + L^2 \pi^2}$$

R is the resistance of the fine wire coil of the wattmeter, including of course any extra resistance in series with the fine wire coil. R^1 is the resistance of the circuit, the power given to which you are measuring. L is the coefficient of self-induction of the fine wire coil of the wattmeter. L^1 is the coefficient of self-induction of the circuit, the power of which you wish to measure, and τ is the interval between two alternations. That expression will be greater the greater is L^1, that is to say, the ratio of what you measure to what you ought to measure will be the greater, the greater the coefficient of self-induction of the circuit power given to which you wish to measure; so that in other words you may expect that when the circuit in question has a very high self-induction, the wattmeter will give you a result far too high. The last thing I wish to say is that it will always give an answer greater than unity; and certainly the ratio of what you think you are measuring to what you ought to measure will increase as the coefficient of self-induction of the circuit power gives to which you are endeavouring to measure is increased, that is, the wattmeter will be least accurate when the secondary circuit has the highest resistance, and will be relatively most accurate when the secondary circuit is of least resistance.

Captain CARDEW explained in detail his safety appliance which is referred to in Mr. Kapp's paper, and said: I have here one that has been used on a circuit. It is here to tell the tale. If you look at it there is a little piece nicked out just where the contact was made owing to some inaccuracy. The thing was not perfectly plane. There is a little corresponding nick just where it is bent up and leaves the iron box. This is perfectly loose and merely lies by force of gravity at the bottom of the box. One end bends by statical attraction. Prof. Ayrton has suggested that these things were not necessary because it was so easy to connect the secondary circuit to earth. That has no doubt occurred to a great many people; in fact, it was a solution which I wanted to see myself, on being asked how this difficulty was to be overcome. If you connect the secondary circuit to earth it is all right for the customer. He won't get killed. But of course the transformer people, that is the people supplying the light, do object to it, and it is easy to see why: because putting the secondary circuit to earth insures that as far as the secondary circuit is concerned there is no insulation, and consequently it means practically an increase of strain on the insulation between the primary and the secondary. Now we talk of insulation, but of course it is a comparative thing, and there is no insulation in a primary that can be really considered perfect. In every transformer it is only a question really of how much leakage is going through the whole of the insulation. Mr. Kapp described another device which, having the same object as mine, I feel rather a delicacy in criticising, and I will only say that as a customer, I should be quite satisfied with it, it effectually separates the secondary from the primary. As a maker of transformers I should treat it as a boon, as I should expect there would be a considerable demand for transformers, but as a supplier of light I should rather object to it.

Mr. BERNSTEIN: We have in addition to the very excellent paper of Mr. Kapp, and the interesting remarks of Mr. Mackenzie, now a paper by Professor Ayrton on the theory of secondary generators for which we are, I am sure, very thankful. It forms another question on which we might be induced to enter. I shall confine myself, however, to a very few points—those in which I feel naturally most interested. One of these questions is that of putting transformers either in series or in parallel. Now, Mr. Kapp has already said that where station light has to be distributed over a large area it might be advantageous to put them in series. But in addition to this I should like to call your attention to some other very important facts. In a system of transformers where we use high-tension alternating currents the question of insulation becomes a very serious one, as we have just heard from Captain Cardew. Now, if you use transformers in parallel you are obliged to use the main conductors, between which there is a very high difference of potential, say two thousand volts, and you are obliged therefore to put them in such a way as to prevent induction on other wires. This makes the insulation under these circumstances exceedingly difficult. When you use transformers in series you only get the highest difference of potential at the dynamo end of your circuit, and you reduce the difference of potential at the line, so that there is a mean difference of potential only half as large, and from a theoretical point of view one would say the tendency to produce a leak would only be a quarter as great. This is a serious matter in the construction of these generators. But in addition to this the matter is of far more importance in the transformer itself. In a transformer on a parallel system you may have a difference of potential of 2,000 volts between the ends of your coil, and as you cannot use a very high insulation in this coil if you want an efficient transformer there is a liability to leakage. In a series transformer this difference of potential may be reduced to 100 volts, or 50 volts, and this enormously reduces the tendency to leakage. There are two very important advantages which the series system has over the parallel system. It is also important because of the question of insulation. There is another question I would like to ask Mr. Kapp. We have been told repeatedly—although there is hardly any distinct evidence, that the efficiency of a transformer is a very high one when the maximum amount of power is used, and that it is reduced considerably when the number of volts is decreased. I do not see why it should be so very considerably reduced, but the statement has been made. Anyhow, I am inclined to think that there are limits to a transformer, electrical and magnetic. The series transformer will offer an advantage over the parallel; but this is a matter on which I shall be glad to have some information from Mr. Kapp in his reply. I shall now turn to another point in the paper, and ask as to the devices for preventing the current from going to the primary from the secondary. First of all, you will see at once that were there is a tendency to short-circuit a primary, there would be with a potential difference of 2,000 volts a tendency to heating. This destroys the insulation material between the primary and secondary, and there is a leak. Where this difference of potential is very much reduced it does not exist. However, we will suppose that it does exist, and that there are devices for preventing it. Such a device as Mr. Kapp's may work very well, but, at the same time, may be a source of a deal of harm if proper precautions are not taken. There is such a thing as "leading" electric currents "into temptation." If they can go to the ground they will surely do this. Let me quote an example. There are in the United States a very large number of arc light circuits, several miles in length, overhead. After these had been introduced it was considered advisable to put lightning arrestors in these circuits. Careful observation was made that formerly it was only a rare case that the lightning took its way through the wire, but as soon as the lightning arrestors were put on it occurred very frequently. These lighting arrestors, in fact, are acting to a great extent as lightning inducers, and the remedy was only found by much increasing the distance between the points, so as to give the current from the lightning more resistance. Now, in making such devices as that of Mr. Kapp's proper precaution must be taken not to give the current too easy a chance to leak from the secondary to the metal plate, and from these to the earth. Prof. Ayrton has mentioned another device, which consists in connecting the secondary directly to earth. Now in regard to that, I should like to mention something on behalf of Prof. Forbes, who is not present. When I first showed to some of the members of this society in my laboratory the contact plug used in my system of series lighting, with which, of course, you are familiar, Prof. Forbes at once made the remark that this contact plug would work exceedingly well to protect the secondary line by making connection to earth, and would be much better than a direct connection, because its principle was this, that as long as the difference of potential between the line and earth is very small, there is hardly any appreciable current going through this. It may have a very high resistance, as much as 5,000 ohms, but as soon as the difference of potential is increased, as would be the case in the event of a leak, then it would at once get into action and make a short circuit. This was a very good idea of Prof. Forbes in connection with this application of the contact plug.

Mr. Preece: Will you, Mr. Bernstein, please describe your contact plug?

Mr. Bernstein: I thought it had been described so often in electrical papers that it might be known by this time, but I had a very distinguished visitor in my laboratory to-day and he did not know of it.

Mr. Preece: It is so very pretty that it will bear description over and over again.

Mr. Bernstein: I am sure I am very thankful to you. I will endeavour to describe it without making any drawing. The contact plug has been designed in order to prevent interruption of the circuit in which incandescent lamps are placed in series, and in case one of these lamps should break. You can at once see that under these circumstances the plug would form a sort of attachment to the lamp, and it is natural that, as the plug has to offer another circuit for the lamp, these parts should be placed as a shunt to the lamp. But any device placed in shunt to the lamp must be of high resistance, otherwise it would take too much of the current. Now, there have been several devices proposed. Most of them consist of electro-magnets placed in shunt, these electro-magnets being wound with fine wire; and in the exhibition in Vienna I have myself shown such devices, which seem, however, to have been entirely overlooked, for I have never seen any description of them in the papers. As soon as the electro-magnet is acted on the spring makes a permanent contact and throws open a way for the current. But all such devices are exceedingly cumbersome: they require adjustment and would make their general application to series lighting with incandescent lamps perfectly impracticable, because they are too expensive, and several of the advantages of the system would be counterbalanced by their use. In order to overcome this difficulty and to do away with all mechanical devices, I have succeeded in getting another method, which consists of the following:—Imagine these two contact pieces as being placed in shunt round the lamp, and to have between them a substance which normally is of very high resistance, but which as soon as an excess of current goes through becomes in itself a conductor of low resistance. Then we would at once fulfil the problem which we intend to solve. Now, there are such substances, take, for instance, that which I now use in the plug—oxide of mercury, which is in itself a non-conductor and mix it with carbon powder. Then you can by this means reduce the resistance of the oxide of mercury to any degree you please. Suppose the lamp has, as is usual in a series system, a resistance of 1 ohm. The mixture might be made to have a resistance of 200 ohms, and therefore take only a fractional part of the current. What takes place if the carbon burns? The resistance of the leak is decreased, and a larger current passes through the shunt. But the larger current will reduce the oxide of course into metallic mercury, which forms a conductor of low resistance between the two terminals of the lamp. This general principle of the plug has now been in operation in a great number of installations for over a year, and I can state to you as a fact that we have never known a case in which it has failed to do its duty. Now, gentlemen, I have made a diversion from what I was going to say, and as it is rather late I think I shall somewhat shorten my remarks. I only wish to say in regard to Mr. Mackenzie's paper that I fully agree with one of the observations he made, and that is, that we should never put electric light fittings on to gas fittings, especially in a system on which high tension currents are used. It is an enormous mistake to do so and always leads to fault. In America it is distinctly prohibited where high-tension currents come into play, and I hear from some of the gentlemen connected with the Edison Company that even on their low-tenson currents they do not like it. It is altogether a bad practice, resorted to to make things cheap, but ought to be abandoned.

Mr. Atkinson: The few remarks I shall make this evening will have reference principally to Mr. Mackenzie's paper on alternate current machines. It is true that the great improvement has been the introduction of iron into the primary. He, however, at once passes on to give as his latest type of machine the Ferranti, which I believe contains no iron in the primary, and this seems to be rather a contradiction to his first question. However, I quite agree with him that the introduction of iron has been a great advance. But the mistake seems to have been made of attempting to work the iron to the same degree of saturation as had been attempted in direct current machines. The builders of these dynamos—the multiple disc dynamo—have found by experiment that with more than six poles there is a great difficulty in keeping down the heating of the iron in the armature. It is well that this be laminated. I ran out roughly a short time ago a calculation, taking as a basis of experiment how many lines of force we might take in an alternate current machine and use without danger of heating, for the magnetic hysteresis, and assuming that the figures as roughly run out, a six-pole machine running at 600 would, taking Mr. Kapp's system of figures, take about fourteen lines to the square inch, which, I believe, is about the maximum they can work when of that size and speed. Assuming that there be no greater hysteresis and viscosity you could not use more than about nine lines to the square inch to produce the same amount of heat, and this points at once to a considerable reduction in the intensity of the magnetic lines of alternate current machines. In the machine which Mr. Mackenzie has described and illustrated, he places on the wire alternate coils which I may term the primary circuit separately excited, and similar coils definitely wound which form the alternating circuit. Now it appears to me that in working this there would be produced equally in both of these coils an alternating electro-magnetism, and that when the machine is excited by a series dynamo, or some dynamo with considerable self-induction about it, there would be a large alternation in the exciting circuit, and as, generally speaking, continuous current dynamos are not constructed to stand that, it would produce a rather curious effect. I do not know whether he has had any experience in that respect. I have brought here a photograph of the dynamo designed by Mr. Kapp and constructed by Messrs. Goolden for producing alternating currents, that has iron in the primary. It has an electromotive force of 30 volts, and weighs 2½ tons, and yields a very fair result. The ribbon consists of steel or cast-iron, and on the arm of which is wound iron tape. On the outside of that is carried iron wire, because the mains come over the top, so as to laminate in all directions. On that core thus built up is securely rivetted through, and through the middle of which are spurs on which to wind the wire. This is one half of the top, minus the ring, which is taken off merely to show the construction of the inside. This ring here is 40 inches in diameter. There are 16 pairs of coils on the outside of it, and the speed at which it runs is 600 revolutions, so that the effect of these driving spurs of holding the wire in position is mechanically good. When running at 1,500 volts, and at full speed, it was accidentally short-circuited, which pulled up the engine, but there was no damage done to the armature, and no wires were shifted in the slightest degree. The machine of Mr. Kennedy up there has the advantage that you can attach these inductors. I do not know what is his experience of the machine. Moreover, he himself admits the advantage of using more than one small machine rather than one very large machine, which in the case of a breakdown is totally collapsed, and further, I think, a point has been made a great deal of that machine of the class here shown, that which we may term the armature circuit—that is, a circuit producing a current but not moving—may be coupled in parallel, or series, as the case may be. But I do not think that anyone will attempt to alter the coupling of a machine of that kind, giving 2,000 volts whilst running; and, generally speaking, it is only for experimental purposes that it is required. The only other point I would refer to is the remarks of Professor Ayrton on the compound winding of transformers. He admits that he has not gone fully into the question. I have devoted some time to its consideration, and have come to the conclusion that somewhere or other "there is a nigger in it." I cannot see how the result is to be produced. In his diagram he shows a coil placed in parallel with the main coil, and draws the analogy with a compound-wound dynamo. Now, it seems to me that we cannot raise the volts in the terminals by putting one coil in parallel with another, for if that coil will produce two volts for every volt of the other coil it will at once begin to work back through the other coil. Perhaps, however, I misunderstand his arrangement. But I am inclined to think, from having considered it, that compound winding of transformers cannot be done.

Prof. **AYRTON**: I would ask Mr. Atkinson's pardon. Two generators put in parallel cannot raise the volts at the terminals without one having higher volts than the other. Of course, it is the simplest experiment in the world. Here is a cell sending a current through a resistance with a certain potential difference there, and by putting two cells in parallel you cannot raise the potential difference there. The E.M.Fs. of these two cells are the same. The potential difference is E.M.F., and the potential difference there cannot, of course, be raised by putting the two things n parallel.

Mr. **ATKINSON**: That result, though, is only produced by reducing the output of the original cell; that is to say, practically substituting the second cell for the original one. If the original cell is still doing its same work of electromotive force as the combined cell, that cell will remain the same as before.

Dr. **FLEMING**: I should like, in a very few words, just to describe some experiments I made in 1885 on a couple of Zipernowski transformers, which were brought over and exhibited at the "Inventions." In that year Mr. Zipernowski brought over two of his well-known life-buoy shaped transformers and placed them in the Inventions' Exhibition. We took the opportunity to make some experiments on them. I may mention that they were wound in order to be arranged in parallel. They were worked from a self-exciting alternating current machine at some distance away, and in order to give an opportunity of seeing how the method adapts itself to the transmission of power over a great distance by means of conductors, we placed the alternating machine as far from the transformers as the conditions would permit, and I believe these two transformers were placed 1,000 feet away from the current-generating machine. Each was intended to work 200 16-candle lamps. I may mention that the primary current was moving under an E.M.F. of about 1,000 volts. At that time Dr. Hopkinson had just drawn attention to some possible danger that might result from the electrostatic capacity of the transformers used, and it seemed to me that this might be obviated or diminished by leading the secondary circuit to the earth. In these transformers exhibited in 1885 the secondary circuit was connected to an earth-plate. After this I learned that Elihu Thompson, of America, writing to one of the technical journals, had suggested that method before, and thereupon, I believe, Profs. Ayrton and Perry wrote also to the same journal that they had suggested it before Elihu Thompson, and there the matter rested. I may also mention, as an interesting fact in connection with these transformers, that Mr. Zipernowski had arranged a method of self-regulation, the exact details of which will be found in one of his specifications of the year 1885. The principle of that method was the use of an additional transformer, so arranged that when additional lamp-light was thrown on the second transformer this additional transformer raised the terminal volts, or tended to raise them, to the normal amount.

Prof. **AYRTON**: I said Gaulard and Gibbs, but I think it was Zipernowski. Did the plan answer?

Dr. **FLEMING**: Fairly satisfactorily. It certainly did effect an improvement. Then our attention was naturally directed to some method of determining the efficiency of these transformers. They were made very large, and the intention in designing them was to get rid of the self-induction of the circuit of the main wire as much as possible. For that purpose the movable frames were wound very large, and the whole of the fine wire was not put into the movable frames: it was put outside the movable frames in the form of a non-conducting resistance in series with it, and the outside frame of the voltmeter. The voltmeter was constant and required a few number of turns. They stood something like two feet high. If that was the frame of the watt-meter then (without drawing the connections) there was no inductive resistance in series with this, which formed the bulk of resistance, and, as in the Siemens wattmeter, there was no mutual induction between the fine wire and the thick wire circuits. Provided with a couple of these instruments, one placed in the primary circuit and the other in the secondary, we made some measurements which would give us something approximating to the efficiency of the transformers at various lamp leads. Just to draw it very roughly. There was a lamp circuit. I will not attempt to draw a Zipernowski transformer, but simply indicate it in this way. There is the alternate current machine; there the fine wire circuit, with its non-inductive resistance placed across these, and the thick wire circuit there. Then, taking the collective reading of these wattmeters, we obtained a curve in which the horizontal ordinates are the power as measured in the external or lamp circuit in watts, and in which the vertical ordinates are the ratio readings of these two wattmeters, expressed as per centages of the lowest reading wattmeter, namely, that of the secondary circuit. Then these figures were plotted down, and showed a curve gradually bending, that getting nearly flat at that point, and the highest ratio of these being about 92 per cent. It is obvious from what Professor Ayrton has said that these figures cannot be correct, but it would be interesting with the apparatus referred to by Prof. Ayrton to ascertain how far the readings taken by a wattmeter built on this plan that gave discrepancies between the real watt efficiency of the transformer differed from those obtained in this way. It is very important that attention should be paid, I think, in connection with transformers, to that question of the actual magnetic lag. There is no question that magnetic lag is a reality and that there is a lagging behind all the time iron is becoming magnetised as compared with that in which the magnetising force comes to a maximum. It follows from this that there must be an effect of magnetisation, or rather I should say, we shall have to modify the method of treating the magnetic resistances of magnetic circuits to assimilate it with the method by which we have to consider the resistance of electrical circuits when dealing with alternating electromotive force. We know perfectly well that we do not obtain the average current in a circuit working under an alternating impressed electromotive force by dividing the average value of impressed electromotive force by the resistance of that circuit, but that you have to substitute for the resistance there that quality which has been called by Mr. Oliver Heaviside the impedance. The impedance is that quantity which takes into account the quality of the conductor in which there is a large lagging behind of E.M.F., and therefore when you are dealing with the magnetisation it would follow from this that in the case of magnetic lag we must substitute for magnetic resistance a quality which might be called the magnetic impedance of the machine, which appears in all the theoretical investigations at present published on the subject of transformers. Special experiments should be made in order to ascertain what are the values of this magnetic resistance corresponding to the same magnetising forces, only operating at different periodicities. The experiments I should like to see carried out on the subject would be the effort to obtain what may be called the relation borne by alternating magnetising forces when working with the same average magnetising force, but operating at different periodicities. With regard to the question of safety, it cannot be doubted that in course of time very many different devices will be designed for obtaining security and preventing the E.M.F. of the primary circuit getting into the secondary circuit. It would no doubt be possible to arrange something on this plan that should be tolerably simple and yet work effectively. If this is the earth circuit [I will draw mercury cups, for the sake of simplicity], this is an interruption of the secondary circuit. If these cups were connected by two bars fixed to an insulated support this would be pulled up by a spring and held down by what practically would be a fine-wire safety catch in connection with the two opposite sides of the circuit, that safety catch being so arranged as to stand the normal difference of potential between these two mains, but as soon as that rises beyond a certain amount, the circuit would be automatically broken. Say that were set to stand 200 volts: then it would give way if the difference of potential was to rise to say 400, and the circuit would be broken automatically. I think these are all the remarks I have to make.

Prof. **AYRTON**: Might I mention that the Zipernowski we used gave an error of 300 per cent. when there was a very small current in the secondary circuit. The greater part of the resistance was now passed in a separate resistance box. The coil was merely a large fine wire coil with comparatively few convolutions. I now think it was made by Zipernowski, but I have never been able to find out definitely by whom it was made.

Mr. **CROMPTON**: I should like to say a good deal on this subject, but I shall not have much mathematics. It will interest some of you, because I propose to deal with this question from a commercial point of view. In order to do that I propose catechising Mr. Mackenzie on two or three most important points, and I should be much obliged if he would come prepared to answer them. I want to know next time (he has been engineer, and has had close connection with some of those large commercial enterprises where alternating transformers have been used) whether he can give us certain information as to the actual efficiency of this system. We have heard a great deal about the efficiency of transformers and dynamos and engines, but I am prepared to give some facts from my own experience. I also wish to ask him whether these high efficiencies claimed when the transformers are worked at their full capacity are maintained when they are worked at a low capacity. That is the whole part that affects the commercial capacity.

The discussion was then adjourned till Thursday, the 23rd of February, 1888.

An ordinary general meeting of the Society was held on Thursday, February 23rd, Mr. **EDWARD GRAVES**, President, in the Chair. The minutes of the extraordinary general meeting held on February 16th having been read and approved, the adjourned discussion upon the following papers was resumed:—"On alternate current transformers, with special reference to the best proportion between iron and copper," by **GISBERT KAPP**, A.M. Inst. C.E., member; "The distribution of electricity by transformers," by **KENNETH D. MACKENZIE**, member; "Formulæ for converters," by Prof. **GEORGE FORBES**, F.R.S.E. (L. and E.), member.

Mr. **LAMB** gave a detailed description of the diagrams exhibited, which illustrated the manner of the connections of the apparatus used in Prof. Ayrton's experiments.

Mr. **J. E. H. GORDON**, B.A.: While fully appreciating the scientific interest of transformers, and fully appreciating the great practical use that has been made of them, I cannot help having a feeling that it is a pity to see so much ingenuity lavished on what, in my opinion, can only be intended for a makeshift, enabling us to go on until something better is obtained—that is, a perfect storage system. It seems a pity to spend time and money in improving the details of that which is not to go on in the future. I have been so far convinced of the superiority of the method of distribution given by storage batteries that I felt inclined to abandon what was identified as my own system. It is not because alternate current machines are bad, but because we think something else is better, that we are inclined to abandon them. The first consideration is the space that is occupied by these machines. We know that experiments have been made by coupling a number of small alternate current machines together, and at the South Foreland they were successful, but that was because they were working on arc lamps. Many of us have tried them, and they will, on trial, work together, no doubt; but they do not work together if they are run for three or four months; they will in that time jump, and that jumping will destroy the machines and take months of life out of the 20,000 lamps. That alone is rather a serious difficulty in coupling machines together, and I think we may take it, in practice—I am not speaking about the laboratory or experiments—we do not couple machines, and we must have very big machines if we are to have alternating current machines to do big work. These take up a considerable amount of space. I do not say that 10 feet is an out-of-the-way diameter for a machine to give 200 to 250 units per hour, which is about what the Paddington machines are doing. Mr. Crompton is making me machines for 100 units, with an armature 16 inches diameter, so that two or three of these on one set do not occupy so much space as one of our alternating current machines, or anything like so much. You must, with alternating current machines, practically put them outside your town, and bring your wires and your mains in. But with the modern direct current machines, and with modern engines such as my friend Mr. Willans is making for us, you can take your machinery so close that you can get an immense power into a small space, and none of your neighbours be any the wiser. We are at this moment putting in plant for 10,000 lights, but with room in the engine house to extend to 20,000 lights, not a quarter of a mile from this room. The engine house is 80 feet by 40 feet, which includes engine, boilers, batteries, and everything else. No doubt it may be remarked that 20,000 lights only represent a drop in the bucket of London lighting, and we have to face the question as to whether we are going to establish very large stations, or be content with stations of about 20,000 lights. We all know that one of the great advantages of central station lighting is the great economy in management and work that is obtained by increasing the number of lights worked from one station. But, gentlemen, that increase does not go on indefinitely. If you have about 500 lights your working cost will roughly be about 10s. per lamp per year. When you go up to 10,000 lights that average is decreased by about 1s. 2d. per light, but after 20,000 lights you do not get any further decrease of the average cost per lamp, because then more machines and men are required. If you have a number of stations working from 10,000 to 20,000 lamps with a direct current, there is the advantage that the stations can be coupled together, one working at one end of the main and the other at the other, so that if anything went wrong at one end the other can help it out. There are certain definite reasons which I think will always make a number of small direct-current machines more economical in working than any big machine, and we might go somewhat briefly into them. The first reason is that the demand for light is, of course, as you know, not constant, it is very small at certain hours and very large at other hours; the maximum demand is, in fact, very much greater than the average demand. The number of lamps going is small till about 3 o'clock, when it gets dusk on a winter afternoon, then it rises steadily and regularly till about 6 o'clock, when it goes up with a rush; then it goes down and remains pretty nearly constant from about 8.30 p.m. to about 10 p.m., which is the time a good many people go to bed; the first batch. Then it sinks gradually until about two in the morning, then the number gets less again. Now, in working an alternating-current machine, we assume that 20,000 lamps is the maximum. In order that there may not be a breakdown at the busiest time, the machines must be powerful enough for 15,000 lamps, which means that engines, boilers, dynamos, and engine-house must all be arranged for that size. We supply by meter, and if the supply be by meter or by fixed contracts based upon what we should imagine the meter to be, a great portion of the machine is only earning revenue for about 1½ hours in the 24; half the power of the machine is wasted for 12 hours out of the 24, but the interest on the cost of that machine is going on for the whole 24 hours. Now look what this means. If you have a storage and work the engines for 12 hours, the maximum current can only be the curve for 4,550 lamps, and therefore for 20,000 lamps, with occasionally 15,000 lamps on at once, it is unnecessary to have machinery of a greater capacity that 4,550. If, however, you desire to work your engines for 24 hours, which may in some circumstances be advisable, you must halve that; you then have something extremely small. I suppose, in practice, what we shall do in designing installations will be to so arrange that the engines can be worked for 12 hours, and then as custom comes in the engine power or battery power can be increased or the engines worked for longer hours. That is not the only point that deals with the capital cost of the plant. The next point is the efficiency of the dynamo. Now, as Mr. Mackenzie knows, perhaps better than I do, and as we all know, the efficiency of an alternating-current dynamo is quite different when it is fully loaded to when it is half loaded. If an alternating-current dynamo is used that will give 4,000 electrical horse-power and give a very good efficiency, say 83 or 90 per cent., whatever it may be, such efficiency will not be got, or anything like it, when the dynamo is working at half, or a third, or even a quarter of its power, there will be a very wasteful action in the dynamo, and not only wasteful, but a mischievous action. That is a small point. There is a much more important point than that. Alternating current machines when used direct, or even more so when they are used with transformers, require for their successful use, that the number of alternations per second shall be sensibly constant; the speed of the engines or dynamos must not be greatly varied; the engine must run at very nearly the same speed whether worked at full power or only a fraction of that power. We are "electrical engineers" now and not entirely electricians, but I will ask the engineers present what the diagram of a quadruple expansion 5,000 horse-power engine will be when working at 1,500 horse-power, perhaps two cylinders worked one way and pulling the other two along, the diagram would be a very peculiar thing. But putting the diagram aside for a moment, experience perfectly shows us that a compound engine working at full speed at a third of its power burns at least twice as much coal per horse-power as when working at its full power. With those smaller units that we use for storage, where we can easily couple them together, or even with larger machines and with storage, we work our engines at their full power until we get as much as we want out of them and stop; there is no working at half-power, either full power or stop; and therefore we are liable to get a far greater economy than we can by working big compound engines under their power. There is still another reason which I said I would allude to, that of having stations placed where the engines will not be a nuisance. London is now being filled with great buildings, residential flats, great hotels, and buildings of that sort, and the best site for a station is somewhere near one of these where, on account of special demands, we can, for the first time, meet the gas companies on their own ground, and utilise our waste products. In our Whitehall installation we are selling every morsel of our waste steam that we are generating, and we are not sending any fraction of it up the chimney, because we have a contract to supply the whole of the hot water required for warming the corridors and baths in the building. I do not think others who supply their current from a distance will dispose of their waste steam in the same way. I hope Mr. Mackenzie will not think that I am trying to disparage the excellent work which his company are doing, because there is plenty of room for all of us; but we must remember certain points. Statistics of the lighting in London are not very trustworthy, but as far as I can get them they show that there are 125,000 gas jets to a quarter of a mile. Now we are all friendly rivals, and whoever of us proves not to be successful will have the pleasure of educating the public up to the use of the electric light and getting them to wire their houses, and then later on they can adopt the most successful system. But there is no rivalry here among ourselves between those two systems of distribution; these two honest systems, both endeavouring to do their work as in their knowledge is best. There is another system which perhaps should be referred to; we have heard a good deal lately about a system for distributing electricity which I think none of us will wish to assist to develop more than we can help, that is the system of distributing electricity from house to house by means of circulars in halfpenny wrappers.

Mr. R. E. **CROMPTON**: I consider that the questions that Mr. Mackenzie has raised at the present moment are of supreme importance. The company that he has been more particularly speaking of, and for which we have the highest respect, the Grosvenor Gallery Company, have done a very great work, and I thank them most heartily in the way Mr. Gordon has done, for educating the people of London to like the electric light, and they are educating them, I may say, in a way that I thank them for again most heartily, because they show how people will put up with any sort of light, and in referring to their system and method of construction and workmanship, I hope they will excuse me if I say that they have a little to learn still in the way of introducing the electric light for which they have arranged installations which are not altogether pleasant to people sitting at a 5 o'clock tea or a Mayfair drawing-room. Well, I believe that Mr. Mackenzie has explained something as to the cause of these things which we must not laugh at, but which are I believe inherent in the system. I believe that with the alternating transformer system as at present arranged, where we are perfectly dependent on what our neighbour does, an accident to your neighbour's transformer affecting you, an innocent person; there are many complications liable to break down, which cannot happen with a direct system of distribution carried on from a series of accumulators or storage centres. I have long had the two systems before me, and I have been working at the subject for the last two or three years, as most of you know. I have carried out several central stations, in which the transformation from high tension currents of 500 volts has been carried down to 100 volts, as usually employed in incandescent lamps, by means of Faure batteries in series, and I have data from those installations which are of use to you. It is no use in such a place as this to discuss questions of management, *i.e.*, wages and matter of that kind; but it is of great use to you to discuss the scientific engineering part of it, that is, the question of which system works with the least horse-power, which works with the least first cost in machinery, least first cost in mains, and with the greatest steadiness and regularity and freedom from breakdown. From these points of view I propose to compare the system by alternating transformers with the system by battery transformers. At this stage I would point out what a tremendous leg up the alternating transformer system has received from Mr. Westinghouse, who is one of the most wonderful men in the world: there is no man like him as an organiser of labour and machinery.

Witness his break; in the face of tremendous opposition from railway authorities he has made his break almost universal, and he has done that by these peculiar pewers. He is a very rich man, and he has had unexampled facilities at his town of Pittsburg, where his most successful lighting has been carried out. But let me tell you that what Mr. Westinghouse has done for the transformer system is exactly what Mr. Brush did for arc lighting, when we saw him send over to England from his well-appointed factory a few years ago complete sets of excellent machinery, and which he now sends to any town in America requiring the electric light of the sort. This machinery can be put up on the spot at a small cost. Anybody who has been to America, and knows anything about American installations, will corroborate me in saying that the electric light machinery as made in the shop is perfection, but the putting up of it is such as would not pass muster in the worst of our English installations. That has been the case with the transformers set up by Mr. Westinghouse, and though perfectly suitable for such countries as America and Australia, where rough workmanship and rough things do, they are quite unsuitable for a civilised town. The alternate current transformer system is a beautiful system, and well suited for such cases; but the moment you bring it into London, the moment it is no longer a rover, as it is at present, over the tops of our houses, but is passed under the streets, then it loses all its advantages. What are its advantages? The advantages are, that you can put down a station and run wires in any direction you please, on account of the peculiar state of the law, and take up a number of customers that could not be otherwise reached at all. It has served its purpose well in doing that, but I say that when the taste for the electric light becomes more universal, when two out of three, or one in every three on the line of route takes the light, that kind of thing will be intolerable, and then must come the day when mains must be laid, as they have been laid successfully, in the streets, and then it will be found that the alternating current transformer system is out of it as compared with the other. I am glad to see that Mr. Kapp, in his paper, practically admits this view, inasmuch as in his last sentence, and a man puts the sense in the last sentence of his paper, he says that he will have to "lay down a net-work," and that Mr. Mackenzie will also have to admit, and I should like to know in what way they can lay them down cheaper than we can for the battery system? In no way. Mains laid down in the streets cost, I may tell you, from 14s. at the lowest to 16s. at the highest, per yard. The smallest copper you can put in cannot be put in for less than 14s., 16s. is quite sufficient. When people talk of copper as if that is all that has to do with the matter, they are talking nonsense. This is not the place for me to go into a long estimate as to the cost of the two systems, that must be done at another time, but suffice it to say that I have figures in my possession, worked out very carefully to see, not by taking the extreme figures mentioned by Mr. Mackenzie, what the result would be by using 100 volts and transmitting that through a 1½-inch cable, 100 volts, 15 ampères at 100 volts potential, and by having 500 volts which is workable. For distances where the generating station is situated from 1 mile to 2 miles from the centre of the district to be supplied, the cost of the two systems is practically identical; *i.e.*, if 10,000 lights have to be supplied in a town, with the generating station situated not more than two miles from the centre of supply, the cost of the maximum number at one time, which I call 10,000 lights, is identical in the two cases, and there is no saving by using the alternating system. Now, I am going to attack the alternating system as an efficient one. We have heard a lot about the efficiency of transformers, and much talk over a few places of decimals as to whether they are 80 or 90 per cent. Mr. Gordon has touched upon one of the weak points, and I will proceed to stir up the wound a little deeper than he has done. He says that we have figures showing that the true efficiency is as high as 80 per cent: I do not believe it. I do not believe that such transformers as will have to be used to go up to the peak of Mr. Gordon's diagram when they are working in the daytime, which is something like not more than one-twentieth of the total output when full working, will have more than 15 to 20 per cent. efficiency. Further than that, these transformers are worked by very large dynamos, Mr. Mackenzie talks about 42 feet, 5,000 horse-power dynamos; and as we are told that the total size of the station is 20,000 lights, it seems to show that they are going to run that station with four of those dynamos. Well, I should like to know how many tons of coal per lamp would be required to work the lamps required in the daytime. I have made some experiments in this direction, and I know from experience in years gone by, and from later experience, what it means to run engines, even with continuous currents, without the aid of batteries, nearly empty. There is no more uneconomical beast on the face of the earth than a compound or triple expansion engine worked down to one-fourth or one-fifth of the total output; as Mr. Gordon says, the two other cylinders are nothing more nor less than air pumps and drags on the others. Mr. Willans could tell us something on this point; but, as a matter of fact, those big engines use two-thirds of the coal, when empty, to what they do when they are full; the proportion being about 20 : 13 or 14. Everybody knows this: Mr. Mackenzie knows it, and he knows how much coal they are burning at the Grosvenor Gallery; I know too; they are burning five times more at the Grosvenor Gallery, lamp by lamp, as I am using at Vienna, that is because I am using accumulators, and they are wasting their coal by keeping their engine running for long hours for few lamps. I can tell you that if Sir Coutts Lindsay had asked me to put him in a battery transformer system two or three years ago in the Grosvenor Gallery, he would have saved enough money in the meantime to have put down copper mains; and I cannot say that the working with batteries would have cost so much as with the alternating transformers. The diagram put before you by Mr. Gordon is almost an exact copy of half-a-dozen diagrams which have been shown to me this evening by Dr. Fleming, which came from the Edison Company in America. The diagram shown by Mr. Gordon is, I believe, based on London experience, and it is almost a correlative of work that I have done at Vienna, and to my great delight I find that it is exactly corroborated by the most interesting diagrams which Dr. Fleming has, in showing that there are peaks of an hour or couple of hours duration where the demand is double, the other maximum demand of three or four hours, and that something like 11 or 12 hours is the average demand. I think the whole gist of the question of economical working lies in the study of diagrams of that kind, and you will be astonished to find that enormous sums of money can be spent on mains and on batteries, with enormous capital charges upon which interest has to be paid, but which interest would be greatly less than the large sums wasted in coal and by the heavy wear and tear of the machinery required to supply demands direct from the engine and dynamo. The whole thing is turning on the one question that was raised by Mr. Mackenzie; he has thrown it out, and the statement has been over and over again asserted that alternating current transformers can be run parallel. If they can be run parallel that will knock the bottom out of a great many of my arguments, there is no doubt about that: but I think it has not yet been done. I have taken great pains to find out whether it has been done in practice, but it certainly has not been done in England nor in America, and until these gentlemen can show us that by following the lines we do, putting one dynamo on with another, and working them to the best of their efficiency and capacity as the demands arise, and filling up the sharp angles between the dynamos by working accumulators in parallel to them, they will never approach the efficiency that we are having at present. I believe from Mr. Mackenzie's statement, and from all the rest that I can hear, that Mr. Ferranti has virtually admitted that they cannot put machines parallel, by his desire to construct these gigantic machines that we have heard of in the paper.

(*To be continued.*)

NEW PATENTS—1888.

2420. "An improved method and apparatus for effecting the regulation of electrical currents." W. H. Scott, E. A. Paris. Dated February 17.

2488. "Improvements in the manufacture of illuminating conductors for incandescent electric lamps." R. Langhans. Dated February 18.

2449. "Improvements in systems of and mechanism for electric railways." O. Allen. Dated February 18.

2450. "Improvements in electrical measuring instruments." W. Hibbert. Dated February 18.

2454. "Improvements in the insulation and method of fixing electrical conductors." W. Moseley. Dated February 18.

2515. "Improvements relating to dynamo-electric generators and motors." J. Feaveryear. Dated February 20. (*Complete.*)

2516. "A new or improved apparatus or inductometer for measuring the intensity of a magnetic field." G. Miot. Dated February 20.

2525. "Improvements in arc electric lamps." C. Richardson. Dated February 20.

2586. "Improvements in and relating to incandescent electric lamps." R. Kennedy. Dated February 21.

2654. "Improvements in the regulation and control of dynamo-electric machines and in apparatus therefor." J. A. Kingdon. Dated February 22.

2666. "Improvements in dynamo machines and electromotors." J. V. Sherrin. Dated February 22.

2667. "Improvements in primary batteries." J. V. Sherrin. Dated February 22.

2689. "Improvements in the construction and method of arrangement of electrical incandescent glow lamps." A. F. St. George, C. R. Bonne. Dated February 23.

2690. "Improvements in apparatus for indicating the depth of water in reservoirs or tanks by electricity." L. Berry. Dated February 23.

2694. "Improvements in batteries." W. F. C. Ward. Dated February 23.

2695. "Improvements in electric lighting." S. Miller. Dated February 23.

2698. "Improvements in the construction of sanitary and magnetic mattresses." E. P. Dove. Dated February 23.

2703. "Improved means or apparatus for sounding at sea and elsewhere by electricity." F. Hargrave. Dated February 23. (*Complete*)

2707. "Improvements in friction dynamometers." G. E. Coupe. Dated February 23.

2726. "Improved means of laying electric light conductors." A. T. Kinninmont, W. H. Gastrell. Dated February 23.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

11487. "Improvements in the manufacture of positive pole-plates for secondary batteries or accumulators." S. FARBAKY and Dr. S. SCHENEK. Dated September 9. 8d. Relates to the invention described in the No. of the REVIEW for last week. There is 1 claim.

13660. "An improved combination electrical switch." D. L. SALOMONS, O. E. WOODHOUSE and F. L. RAWSON. Dated October 25. 8d. Claim:—The combination with an ordinary switch of a movable connector through which an independent lamp or other circuit is connected, auxiliary to the circuit or circuits connected to the ordinary switch, substantially as and for the purposes specified.

16661. "Improvements in self-regulating dynamo-electric generators." R. P. SELLON and C. E. WEBBER. Dated December 18. 8d. In alternate current generators when it is required to maintain the condition of constant difference of potential either at the terminals of the generator, or at some distant point of the mains, the inventors excite the field magnet or magnets partly by any of the usual known or other suitable means, such as any separate source or by means of one or more coils, or portions of the armature conductor provided with a commutator for the purpose, or by the commuted secondary current of a transformer the primary of which is a shunt on the terminals or mains. Across some portion of one of the main conductors or resistance placed in the main circuit, they take a shunt or derivation which is connected by means of a commutator and brushes in the manner usual in correcting or commuting alternate currents with a separate coil on the fields or with the initial exciting circuit already refered to. The shunted and commuted current so obtained is employed to strengthen the fields and as it is proportional to the main current, it is by suitable proportioning of the machines enabled to maintain a constant or such rising or falling difference of potential as is required. For constant current working this shunted and commuted current may be made to exercise a demagnetising effect. The claims are 11 in number.

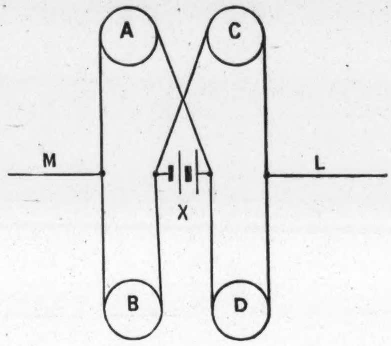
16865. "Improvement in coupling up batteries for lighting and other purposes." L. R. DAVIES and M. SHEARER. Dated December 23. 8d. Consists of two or more cells of any suitable form or material coupled up to enable one or more to be switched on and off alternatively as the current requires, so as to give time for each cell or cells to recover themselves, and thereby cause a continuous current. The commutator to be worked by clockwork or to be automatic. The claims are 3 in number.

16879. "Improvemets in the transmitting and receiving apparatus of printing telegraphs." W. S. STELJES. Dated December 23. 8d. Claims:—1. The construction of the escapement pallets in two parts, so that the escape wheel can readily be set free from the pallets, snbstantially as described. 2. The arrangement of the mechanism for bringing the instrument into unison with the transmitting instrument, consisting of a magnet whose armature when a current of increased strength is sent into the line is attracted and operates through a lever to set the escape wheel free of the pallets, and to insert a stop in the path of a projection rigidly connected with the escape wheel, so as to bring it to rest at the zero or unison point, substantially as described. 3. The arrangement of mechanism for preventing the impression lever from forcing the paper on to the type wheel when the spacing or unison key of the transmitter is operated, comprising an armature attracted to its magnet by the spacing or unison current and operating to short circuit the impression magnet, which then only attracts its armature sufficiently to operate the ratchet mechanism to feed on the paper for the blank space, substantially as described. 4. The means for automatically synchronising the receiving instruments with the transmitting instrument, substantially as described with reference to the drawings.

17018. "Improvements in and appliances for transmitting electric currents in electric rail or tramway systems." M. HOLROYD SMITH. Dated December 29. 1s. 6d. Claims:—1. In electric rail and tramways a switch box, the magnetic bar of which is opposite to the connections to the surface bars, said bars being also flexibly connected with the contact maker with the main conductor, substantially as set forth. 2. In electric rail and tramways, the combination of two or more surface bars with a battery carried by the car and adapted to operate the magnetic switches through which the main current passes to the motor, substantially as set forth. 3. In electric rail and tramways a magnetic ring switch, the movement of the armature of which is governed by the position of the car upon the line, substantially as set forth. 4. The improved arrangement and construction of switch boxes, substantially as described and illustrated in the drawings. 5. The combination of magnets, so constructed and arranged in an electric switch box that the contact is effected by means of a battery current and maintained by said current, or by the main current, substantially as set forth. 6. The improved electric fuse, substantially as described and as illustrated in the drawings.

1887.

211. "Improvements in and relating to telephonic apparatus." THE STANHOPE COMPANY, LIMITED, and G. L. ANDERS. Dated January 6. 8d. Relates to electric telephones operated by the vibration of an armature or armatures in front of an electro-magnet or electro-magnets, such electro-magnets being wound with and excited by coils of wire placed in the main circuit or line. The invention consists in the method of connecting such coils with the exciting or line battery in such a manner that the coils form what may be termed a balanced bridge, so that the electro-magnets will be highly charged and sensitive, while the balance will be disturbed by currents entering from a source outside the balance or by currents generated by vibration of an armature or armatures in front of one or more coils forming part of such balance. The fig. illustrates this arrangement, X being the battery and L the line. A and B are equal coils, C and D are equal coils, and M is the return or earth wire. It is not necessary that all the coils shall be of equal resistance, but the pair joined to earth should be equal to each other, and the pair joined to line should be equal to each other. It is evident that two or more coils in series or in parallel may be used instead of any single coil provided that the resistance of such substituted coils so arranged be equal to the resistance of the corresponding balancing coil or coils. It is also evident that one or more of the coils may be used as or be substituted by balancing resistances doing no electro-magnetic work. The claims are 4 in number.



9744. "Improvements in or relating to electric conductors or cables." W. P. THOMPSON. (Communicated from abroad by G. Westinghouse, jun., of America.) Dated July 12. 6d. Claims:—1. The combination of a central conductor, a covering of insulating material, and two or more independent conducting plates applied to the opposite sides of the same, and curved to conform to the surface thereof. 2. An electric conductor consisting of a central conducting core, an outer conductor constructed in longitudinal sections curved to conform thereto, and an intervening insulating material. 3. An electric cable or conductor consisting of a central core, an outer conductor in longitudinal sections curved to conform thereto, an insulating material between the two, and an external covering.

CORRESPONDENCE.

Magnetic Resistance.

Do you like the notion of "magnetic resistance" introduced within the last few years into scientific works in connection with dynamos and transformers? There are some, like Mr. Oliver Heaviside, who will not speak of it; others, on the contrary, find the employment of this factor very convenient—all theoretical considerations excepted—and I am among these last.

But it must be understood, once for all, and it is for this that I ask your intervention, upon the definition of this magnetic resistance, which threatens to become a Babel, if not set in order.

1. By Mr. Kapp—first system—and Prof. George Forbes, the magnetic resistance is defined by the equation

$$R = \frac{1}{\mu} \quad \frac{l}{s}$$

μ being the permeability, l the mean length of the flow of force, and s the mean section which it traverses.

This definition corresponds to that which we derive from the equation:

$$\phi = \frac{F}{R},$$

ϕ being the total current of induction, F the magnetomotive force, and R the magnetic resistance.

2. M. Bosanquet wishes (see the meeting of the Physical Society of February 11th) that the magnetic

resistance should be the quotient of the magnetomotive force by the magnetic induction (a magnetic flow per unit of area).

3. In his last work on transformers Mr. Kapp—second system—gives the equation

$$R = \frac{l}{s},$$

the magnetic resistance being then the relation of a length to a section without taking account of the permeablitity

The *true* expression of the magnetic resistance is not, perhaps, any of the three above expressions, but it is time to determine it before we have three or four dozen. The study of electrical and magnetic phenomena is not already so simple that it may be further complicated at pleasure every day by new definitions to which are applied names already applied to other physical quantities.

I content myself for to-day with pointing out to you the evil. Your readers will certainly not neglect to suggest remedies for putting an end to this deplorable state of things.

E. Hospitalier.

Paris, *February 27th*, 1888.

Safety Fuses.

In your issue of the 17th inst. you kindly published a letter showing how Mr. Cockburn had, in his paper on "Safety Fuses, &c.," led people to believe that he was the inventor of the strained fuse wire; and also showing that he was not the first inventor thereof.

In his reply of last week he totally ignores the point at issue, in order the better to cry his own wares. The spirit of the letter is well shown in his first sentence; he says that I evidently know but little of the subject upon which I write, or I should know better than to advocate additional loose contacts in an electric light circuit. Now, so far from advocating loose contacts, I advocated no fuse or form of fuse whatever, in this respect differing from Mr. Cockburn; hence I am relieved of the necessity of revealing my identity in order to prove this ill-mannered and unwarrantable statement false.

Mr. Cockburn, in the words of Descartes, seems to be like a blind man, who, in order to fight on equal terms with one who sees, would have him descend to the bottom of an intensely dark cave. He would draw me into a discussion on the comparative merits of the fuses, in order to get rid of the question raised in my first letter. Should I have leisure to complete some experiments on the subject of strained fuses, I will, with your permission, lay them before your readers in your other columns.

With reference to the use of a strained copper wire, as advised by Sir Wm. Thomson, in preference to one of fusible metal, as advocated by Mr. Cockburn, the latter says, "the copper and silver wires tried *by me* always got red hot before fusing," but he does not state that they were strained, or if so, to what extent. Again, copper would be far better able to stand the constant strain (stress) than a soft, almost plastic wire; and would thus have greater constancy, as the wire would not be drawn out.

Mr. Cockburn suggests that I should read his paper, and offers me a copy of his "patent" (probably *specification*), all of which I had carefully studied, in order to find out what advance had been made by him in the application of safety fuses; at first I thought that the straining of the wire was a distinct advance, but finding that it had been invented by others in 1883 and 1884, I saw very little remaining to Mr. Cockburn's credit.

Electrophile.

February 28th, 1888.

With reference to the correspondence on the above subject, there is one point in connection therewith I should like to discuss, namely, the most suitable position for the fuse on lamp circuits.

I have a strong objection to the present practice of putting the fuse inside ceiling blocks or plates. In the event of an accidental short circuit, the position of the fuse would render it most difficult to renew. The best place I believe is in the switch, which of necessity must be easily accessible.

The object of the fuse is to prohibit the leading wire from heating and catching fire in the event of an excessive current passing. Now a No. 18 B.W.G., which is the size most frequently employed on lamp circuits, will stand a current from 30—40 ampères for an appreciable time without being injured. There should be therefore a large margin in favour of the wire.

Now, as a matter of fact, the fault invariably occurs in the fitting; therefore so long as the fuse is placed outside the fitting, it will protect the circuit. Up till now I have invariably used copper threads as fuses on lamp circuits; but although they have never failed to act when called upon, they certainly cause a "a bit of a splash." This defect, however, I hope to overcome by employing the platinum fuses of Mr. Preece.

There would be hardly room in an ordinary switch for Mr. Cockburn's weighted fuse, but I think they might be very suitable on distribution boards.

R. Frederick Yorke.

February 28th, 1888.

M. de Wolffers's Criticisms.

With reference to M. de Wolffers's remarks on my "Notes on Continental Lighting," I would explain to him that my stay in Paris was extremely short, and this accounts for the few hurried lines devoted to this city. I had no intention whatever of giving a *resumé* of Parisian electric lighting, as it would have absorbed a very considerable period to obtain the necessary particulars. I find the name of the square fitted with electric lamps and pillars was mentioned in error as the "Place de la Concorde;" this should read, "Place du Carrousel," which is not far from the other.

As I have seen a considerable number of Jablochkoff candles at work, I at once noticed they differed from the lamps placed on the top of the iron pillars referred to; but being informed, on enquiry, that they were a certain type of Jablochkoff, I concluded they were a class peculiar to the country, with which I was quite unfamiliar. I am much obliged to your correspondent for stating that they are the "carbon regulators of de Mersanne."

As regards the Opera House (fitted, I understand, throughout with the electric light), I consider this building to have by no means an ancient appearance, although it is hardly new, as M. de Wolffers states; and even yet it retains its title, "Le Nouvel Opéra." It possesses an enormous amount of costly and attractive ornamentation, but has also several architectural defects. Owing to shortness of time at command I could not obtain particulars of the lighting installation here, as I should have liked to do.

I may state that the information given *re* the other Continental cities was more carefully vouched by me and by an official connected with each place I visited, and is therefore generally correct.

With respect to M. de Wolffers's apparent slight of my linguistic attainments, I would respectfully inform him that I suffer no serious inconvenience under this head, as I have sufficient knowledge of several languages to render valuable assistance when travelling abroad, without laying pretensions to excellence, bearing in mind the Latin words, *Humanum est errare*, as a saying from which category no man is exempt.

As regards M. de Wolffers's remarks that the lighting of altars at churches by candles will continue for some time yet, I am strongly of opinion that as church services undergo changes to suit the times, and the electric light comes into more general use, we shall (in our English churches, at any rate) adopt that light which proves itself to be a model of cleanliness and purity.

These advantages are claimed for the incandescent electric lamps, and if the light could be supplied cheaply (which is simply a matter of time), and its general adoption thus ensured, it would raise the whole moral tone of the community at large.

B. H. Collins.

February 28th, 1888.

Galvanic Belt Fraud.

I shall be glad if you will kindly allow the following letter, which I have received from Mr. H. Newman Lawrence, to appear in your journal. I need hardly mention that I quite agree with Mr. Lawrence that the Institute is a most fitting agent to carry out my proposal, namely, to publish several thousand pamphlets containing the report and correspondence on the galvanic belt frauds which have appeared in the columns of your valuable journal. I strongly recommend that one of these proposed pamphlets be specially brought under the notice of the various newspaper editors, many of whom, I venture to state, are quite ignorant of the gross injury these medical quacks are inflicting on men who have well qualified themselves as medical electricians, as well as thousands of honest and hard-working individuals. This golden opportunity of dealing a severe blow at these cunning swindlers and robbers of the poor and ignorant will, I trust, not be lost.

J. Jerritt, *A.S.T.E.*

[COPY]

The Institute of Medical Electricity,
16, Clifford's Inn, Chancery Lane.

Dear Sir,—Having noticed your letter in the ELECTRICAL REVIEW, I write to say how heartily I approve of your suggestion. One of the main objects of this Institute is, as you will see from the enclosed papers, to rescue curative electricity from the hands of quacks, and give that considerable section of the public which seems so anxious for electrical treatment an opportunity of getting genuine scientific advice and treatment at reasonable fees. This company was only registered to-day, so that I cannot give any pledge in the matter; but I would venture to suggest that the "Institute of Medical Electricity" is a most fitting agent to carry out your proposal.

H. NEWMAN LAWRENCE,
Managing Director.

Transformers.

In your article on "Transformers" in last week's issue of the ELECTRICAL REVIEW, you make some remarks upon the work done "under stupendous difficulties" by Mr. Gaulard and myself, for which appreciative acknowledgment is due. Later on, in the same article, you say, referring to the early installation at the Grosvenor Gallery ". . . . . the series system of Gaulard and Gibbs being finally abandoned, and the parallel system of Ferranti substituted in its place."

You will, I am sure, allow me to correct the error to which you thus give publicity. The fact is that the installation at Tours, in France, was laid down on the Gaulard-Gibbs system in parallel before Mr. Ferranti began to copy us.

The National Company supplied series secondary generators to the specification of the engineers of Sir Coutts Lindsay & Co. The engineers of the National Company were not consulted, or even allowed to interfere when difficulties arose.

The National Company made and delivered to Sir Coutts Lindsay & Co. parallel secondary generators, which were accepted as efficient by the engineers of Sir Coutts Lindsay & Co. one month before a single Ferranti transformer had been placed on the Grosvenor Gallery circuit.

The "sad case" forming the subject of a paragraph in another part of the same issue of your journal appears to be an imperfect translation from a French newspaper. The narrative has probably only a substratum of truth. It is, however, unhappily, the fact that Mr. Gaulard's mind has given way; his naturally excitable temperament led him to feel excessive irritation at seeing ungenerous infringement following so closely in the wake of absolute incredulity.

J. Dixon Gibbs.

February 28th, 1888.

The Crompton-Swinburne Dynamo.

When I read your article on the Crompton-Swinburne dynamo in the issue of February 3rd, I received the impression, no doubt in common with others, that the writer believed he was describing a new invention of importance. As Mr. Swinburne had found out previously that the use of embedded wires was no new discovery, I think he might have taken steps to stop the insertion of something supposed to be new that was, in reality, quite old. While I do not doubt that Mr. Swinburne can increase the output per weight of the whole machine, if the alteration shown in fig. 3 is a success, from my experience with this type of armature I do not think he can increase the output for a given armature twice or fourfold without it becoming unduly heated. I also find it hard to believe that the machine shown in fig. 1, with the field magnets of the Manchester, or more properly, McTighe shape, will give an output compared with total weight very different from those constructed at present.

As perhaps I have had the longest experience with "hole" armatures, I may be allowed to make some remarks on them which will tend to clear up the matter. First as to priority:—My first armature with the wire embedded in holes was finished in September, 1885. In 1886 I obtained a grant of provisional protection, but finding later on that the same idea, with some modifications, had previously struck Wenström, Parsons and Hookham, I did not complete the patent. In Wenström's specification it is pointed out that the holes are open for bringing in the wire, and afterwards closed by a non-magnetic substance. Parsons's idea was to counteract the effect of centrifugal force in his dynamo coupled to his high speed steam turbine. In Hookham's patent the use of embedded wires is claimed. He states that the form is suitable for very large machines, or those in which only a low E.M.F. is required, *e.g.*, for electro-plating. Up till recently no one besides myself has, so far as I am aware, actually constructed these armatures.

As the result of my experience in manufacturing these armatures, I may point out the principal advantages and disadvantages of them. They give the most striking advantages when employed in multipolar machines, where, as everyone knows, the air resistance is high in comparison with two-pole dynamos. As an example, I may mention that I made two armatures for a machine of 10,000 watts, That without holes had double the number of wires on the other, but both gave nearly the same tension when revolved at the same speed in an equally excited field. In two-pole machines, especially in large sizes where the air resistance does not enter so much into the result, the advantage is not so great. The "hole" armature, however, presents some mechanical advantages, viz., the wire when once placed in the holes cannot be injured in mounting and dismounting the machine, and also no binding straps are necessary. In case of repair it is very easy to withdraw one wire only. A disadvantage is that it can scarcely be used for high tension armatures, as it is difficult to obtain high insulation, and it is also not easy to place more than one wire in each hole. By using embedded wires there is no heating of the poles of the field magnets, and when the machine is properly proportioned, the heating of the armature iron is quite moderate. To conclude, it will be seen that the answer to the question whether or not to employ a "hole" armature depends entirely on the conditions under which it will be employed.

C. E. L. Brown.

February 21st, 1888.

The Brush Company's Proposal.

Seeing that you have invited your readers to express their views on the situation relative to the proposal of the Brush Electric Light Company to light a certain area of the City of London, I hasten to inform you that it is with feelings of the deepest regret myself and some friends interested in the introduction of the electric light to Dublin, have read of what may be designated the "dog in the manger" interference at the eleventh hour of the Maxim-Weston Company.

For some time past we have been watching with no little anxiety the progress of this proposal, believing with you that its final acceptance would be the means of imparting a considerable impetus to the electrical industry.

It is much to be regretted that those praiseworthy negotiations (now extending, I believe, over some years) on the part of the Brush Company to undertake an interesting and highly important work, on a legitimate and proper commercial basis, should be, as it were, invaded by the overtures of a practically untried company, whose electrical apparatus has not as yet come very conspicuously before the public.

It would have been very much more conducive to the interests of the electric light generally if Mr. Watt's company had gracefully stood aside and allowed the work in question to be carried out without obstruction by those who had spent so much time and energy in working the matter up to its present point.

I believe that until some such general scheme as that proposed is in practical operation in London, we in the provinces shall have to wait a long time before our desire to see the new illuminant installed in our streets and houses is gratified.

Therefore it is that I earnestly hope the City Commissioners will reconsider their decision of Tuesday last, and find it to their convenience to come to terms with the Anglo-American Brush Company for a grand scheme of electric lighting on a sound commercial basis.

Angelo Fahie,
Mem. Soc. Tele. Eng. and Electricians.

February 27th, 1888.

Wire-Renewing Levers.

The device of Mr. Gilbert in this week's issue of the REVIEW is not new, except perhaps in the use of steel for the arms.

Renewing arms are easily constructed of wood, using ordinary shackle cones as runners, with guards to prevent the wire passing off accidentally.

Clips for attaching the arm to the ordinary pole arm are not difficult to design.

This method undoubtedly prevents the interruptions consequent upon pulling new wire up through working circuits. It is in use upon this railway, and is, I believe, also the practice upon the Midland.

In renewing the interior wires on H poles, fix the runner midway between the two interior insulators; then, if the wire is pulled up fairly straight, no contacts can be caused.

Frederic Wyles.

L. & S. W. Railway,
February 25th, 1888.

Snowstorms.

The short article on snowstorms in your issue of February 24th is, I think, a very appropriate one, and the advice given with reference to staying should be appreciated by all telegraph and telephone engineers.

With respect to this branch of telegraph construction I think many would be benefitted by more frequent and lengthened articles on the matter—in fact, the whole subject of outside construction is generally conspicuous by its absence, rather than otherwise, from our technical journals; and I am certain that a very large portion of outside work is done more by "rule of thumb," if I may be allowed the expression, than there is any necessity for, particularly as regards staying.

This being so, there is no doubt many stays are neglected where they are really required, through seeming difficulties which could probably be overcome if the constructor had a little theoretical data to guide him; and, on the other hand, many stays are put in where they are really not required, but simply because there is a slight "pull," as it is called, on the pole, no consideration, or hardly any, being given to the weight of the pull or strain, and the strength of the pole being able to withstand such weight. And, again, a stay may be made up of more wires than are necessary to do the work required. These are obvious evils, inasmuch as a great waste of material and labour must necessarily be involved, and in some instances a stay may do more harm than good.

Again, where standards are erected on buildings, some means of calculating the weight they will probably have to bear, both direct and at angles, would be specially valuable. This, I consider, very important, as there is no doubt standards are overcrowded with wires in many instances, the buildings on which they are erected, perhaps, not being calculated to bear such an extra weight.

Some ready means of estimating the weight of a proposed standard, and what it is expected to have to support, would no doubt be of assistance in the obtaining of wayleaves, especially where architects of buildings are applied to.

With these objects in view I venture to express a wish that you could induce some of your valuable contributors to favour us with articles on outside construction, and, as regards the particular points I have mentioned, I would suggest the desirability of formulating some such tables as the following:—

Span.	Sag.	Weight at supports.	Strain in lbs. on support at a given angle.

Such a table being given for the three classes of wire most frequently used, viz., No. 11 G.I., No. 14 and No. 16 copper.

It might be difficult to give a table of the strains at a number of different angles, but a means of calculation might be shown.

Supports.		
Description.	Average sectional area.	Breaking strain in lbs.
Norwegian pine		
English larch		
Pitch pine		
Iron		

As for the liability of poles to bend or lean, their length and the nature of the ground in which they are erected must be taken into account.

Stay wire.—It would only be required to find the direct breaking strain of the size to be used, to decide how many wires to use for a required stay, and this of course can be got from various books now in circulation. In fact, the information I have suggested as being required may possibly be obtained from a similar source, but as yet I have never seen it given, and should of course be glad to be referred to such source if there is any.

I am sure you will readily open your columns to this subject if you think it of sufficient importance, as I am also certain that there must be among your many capable contributors some one willing to devote a little attention to this subject.

Celt.

February 27th, 1888.

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